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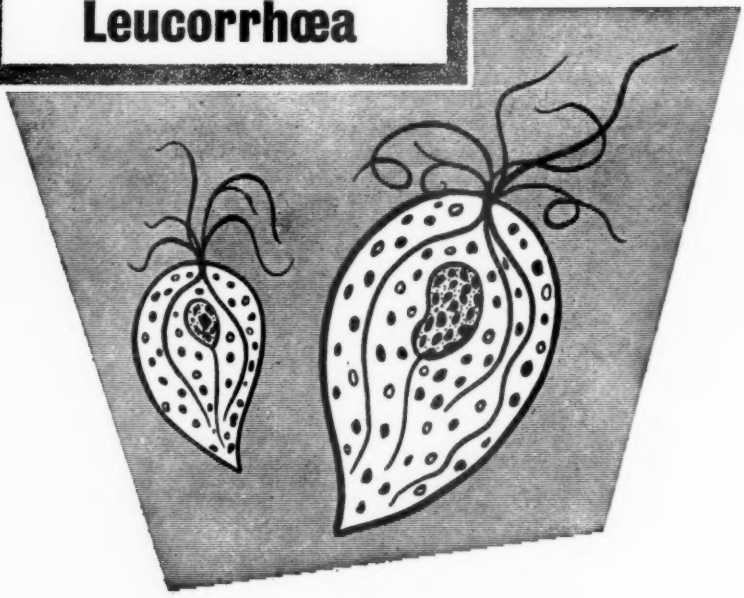

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CONTENTS

	Whole Proceedings Page
Section of Epidemiology and Preventive Medicine	
October 17, 1952	
Environment and Childbearing.—D. BAIRD, M.D., F.R.C.O.G., and R. ILLSLEY, B.A.	53
November 21, 1952	
DISCUSSION: RESPIRATORY INFECTIONS IN CHILDHOOD	59
Section of Medicine	
DISCUSSION ON INTESTINAL GRANULOMATA AND RETICULOSES	65
Section of Anæsthetics	
Aids to Anæsthesia.—President's Address by M. D. NOSWORTHY, M.A., M.D.	75
Section of Obstetrics and Gynæcology	
October 24, 1952	
Changing Practice in Obstetrics and Gynæcology.—President's Address by A. C. PALMER, O.B.E., F.R.C.S., F.R.C.O.G.	81
November 28, 1952	
The Amplification and Recording of Fœtal Heart Sounds [*Abridged*].—ALISTAIR L. GUNN, B.Sc., M.D., F.R.C.S.Ed., F.R.C.O.G., and MICHAEL C. WOOD, M.A., M.D., D.M.R.	85
Fœtal Distress in Postmaturity [*Abridged*].—S. G. CLAYTON, F.R.C.O.G.	91
The Oxygen Saturation of Umbilical Artery and Vein Blood at Birth, with Special Reference to Cord Obstruction [*Abridged*].—C. A. B. CLEMETSON, M.A., B.M., B.Ch.	94

Continued overleaf

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CONTENTS (*continued*)

	Whole Proceedings Page
Section of Orthopædics	
October 7, 1952	
(1) Result of Synovectomy of Hip for Tuberculosis in a Child. (2) Result of Synovectomy of Shoulder for Tuberculosis in an Adult.—M. C. WILKINSON, M.B., F.R.C.S.	99
Six Cases of Arthroplasty of the Hip in Amputees.—LEON GILLIS, M.B.E., M.Ch.(Orth.), F.R.C.S., F.R.C.S.Ed.	100
Acrylic Arthroplasty of Interphalangeal Joint.—F. G. WARD, F.R.C.S.	101
Osteochondrodystrophy (Brailsford, Morquio).—G. G. FARRINGTON, F.R.C.S.	103
Osteopoikilosis (Familial Disseminated Osteosclerosis).—G. R. FISK, M.B., F.R.C.S., F.R.C.S.Ed.	103
Lesion of Left Ilium.—D. L. Evans, F.R.C.S., for T. M. PROSSOR, F.R.C.S.Ed.	105
Neoplasm of Upper End of Left Femur.—D. L. EVANS, F.R.C.S., for Sir STANFORD CADE, K.B.E., F.R.C.S.	105
List of Other Cases Shown	105
November 4, 1952	
SYMPOSIUM ON PROBLEMS OF FRACTURES IN THE AGED	106
Section of Surgery	
October 28, 1952	
Acute Pancreatitis.—LAURENCE S. FALLIS, M.D.	113
November 5, 1952	
DISCUSSION ON RECONSTRUCTIVE ARTERIAL SURGERY	115
Section of Laryngology	
Cortisone and ACTH in the Treatment of Allergic Rhinitis [*Abridged*].—President's Address by J. P. STEWART, M.D., F.R.C.S.Ed., and M. Z. KAWA, M.B., Ch.B.	131

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Proceedings of the Royal Society of Medicine Vol. 46 53

Section of Epidemiology and Preventive Medicine

President—Professor ROBERT CRUICKSHANK, M.D., F.R.C.P., D.P.H.

[*October* 17, 1952]

Environment and Childbearing

By D. BAIRD, M.D., F.R.C.O.G.
Regius Professor of Midwifery, Aberdeen
and R. ILLSLEY, B.A.
Social Scientist, Social Medicine Research Unit, Medical Research Council

Professor Baird: The great importance attached to a thorough training of doctors and nurses wishing to practise midwifery has possibly exaggerated the importance of the part they play in pregnancy and labour. For example, the impression is created that they play an active and essential part in normal parturition when, in fact, most women deliver their babies almost unaided and the outcome of pregnancy depends more on the physiological efficiency of the mother than on the standard of medical and nursing care. The healthier and more efficient the population, the less elaborate need the maternity services be, so that money and resources spent on education and social services and on preventive medicine should result in saving in expenditure on curative medicine.

It seems reasonable to suppose that those reared in a good environment will show better results in childbearing than those brought up in poor circumstances. In the past, this has not been at all clear from mortality statistics, since maternal mortality was just as high in Social Class I as in Class V, and although there was a social gradient in the case of stillbirths the difference between the rates in Social Classes I and V was slight compared with that for infant mortality.

One of the striking medical facts of the war years in Britain was a great fall in the stillbirth rate, and analysis of causes of stillbirth in Scotland (Duncan, Baird and Thomson, 1952) suggests very strongly that the biggest individual reason for the wartime fall was improved health and nutrition of the mothers as a result of full employment and the national food policy. This has produced a much greater interest in the environmental factors affecting reproduction.

Some years ago I compared the efficiency of childbearing in two groups—private patients who entered a nursing home and paid a fee to a general practitioner or specialist, and hospital patients who used the free hospital service.

When groups similar in age and parity distribution were compared, the stillbirth rate in hospital cases was about twice and the neonatal mortality three times that of the private patients. The biggest difference was in the prematurity rate and in death-rates from prematurity. The private patients were taller and looked healthier than the hospital patients. Fig. 1 gives the obstetric death-rate

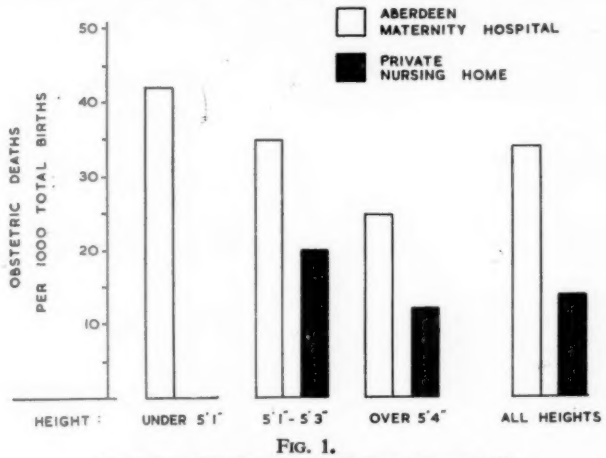

FIG. 1.
OBSTETRIC DEATH-RATE BY HEIGHT AMONG 1,698 HOSPITAL AND 293 NURSING HOME CASES.
Booked married primiparae under 25 years of age.

(stillbirth rate and first week deaths) by maternal height and it shows that in both groups the obstetric mortality fell as the height of the patient rose. Tall women had fewer serious complications of labour than small women, since the size of the pelvis is proportional to the height of the woman (Bernard, 1952). The excess fœtal mortality in small women was, however, not confined to deaths from birth trauma but occurred in all causes of fœtal death suggesting that small women (under 5 ft. 1 in.) are often stunted and less healthy than tall women (5 ft. 4 in. and over).

The health and physique of patients were assessed and graded at the first visit to the antenatal clinic and, although admittedly the method was rather subjective and open to criticism on this score, nevertheless those women assessed as being in very good or good health had only half the prematurity rate and half the obstetric death-rate of those assessed as poor or very poor. The fact that this difference in rates was seen in each height group indicates that the known obstetrical advantage of being tall did not influence the physical grading.

A spontaneous delivery by the vertex in less than twenty-four hours seems to be a reasonable definition of normal labour. The incidence of such deliveries among primigravidæ in the present study fell from 80·7% in the age group 15 to 19, to 26·7% in those of 35 years or more. Conversely, the percentage of labours lasting forty-eight hours or more rose from 2% in the youngest to 8·6% in the oldest age group. The incidence of forceps delivery and Cæsarean section rose steeply with age, demonstrating very strikingly the advantage of youth in ensuring an easy and short labour.

To summarize.—The fœtal mortality and prematurity rates are lowest where the mother is tall and healthy, and highest where she is small and unhealthy. Both fœtal mortality and the incidence of difficult labour rise with increasing age in primigravidæ. Primigravidæ in the lower income groups, although smaller and less healthy, are younger than those in the upper economic groups. The age factor must always be taken into account when comparing social groups, since the beneficial effect of youth in the lower income groups counteracts to some extent the bad effect of poor environment.

The method of classification which I have used is rather crude, yet it has given very interesting results. It was therefore decided to examine the problem in more detail and during the last two years we have been fortunate in having the help of the Social Medicine Research Unit of the Medical Research Council which seconded members of its staff to Aberdeen to work on this problem.

Mr. Raymond Illsley, our Social Scientist, will describe the techniques of social classification which he has used.

Mr. Raymond Illsley: The ultimate purpose of our enquiry is to understand more fully the operation of the various social factors which may influence the course of pregnancy and childbirth. This task calls for a wide variety of skills, and a team was therefore established which included a nutritionist, dietitians, psychologist, sociologist and social field workers, as well as the obstetrical staffs of the Midwifery Department and the Aberdeen Maternity Hospital.

Primigravidæ were selected for special study because they represent approximately 40% of all births in Great Britain and because medical complications are very frequent in this group. Medical data and a few basic items of social data (social class, age and duration of marriage) are available for all married primiparæ resident and delivered in the city of Aberdeen in the years 1949–51, irrespective of the place of confinement (3,013 cases). More detailed medical information and a wider range of social data are available for the 85% of married Aberdeen primiparæ who booked for the Maternity Hospital (2,610 cases). A random one-in-six sample of booked hospital cases was studied much more intensively. For example, the psychologist studied their intelligence, emotional stability and attitudes to marriage, pregnancy and motherhood. Home visits were paid during pregnancy by dietitians who studied food intakes and the methods of cooking, and by social field workers who investigated their social circumstances and their preparations for the baby. They also compiled detailed personal histories of each patient from infancy to the birth of their first child. The enquiry was therefore conducted at three levels: (1) a wide epidemiological study of a universe (all married primigravidæ in Aberdeen), (2) a more detailed survey of 85% of the total (i.e. the hospital group) and (3) intensive case studies of a sample of the hospital group. The "intensive" and the hospital cases can easily be related to each other and to the population-at-risk, an advantage not commonly found in intensive clinical studies.

The field work is incomplete and shortage of numbers makes it premature to report at this stage on the effect of environment on the complications of pregnancy and labour. For reasons of space I shall omit reference to the nutritional, psychological and economic aspects of the survey and discuss only the relationship between a few selected social factors and biological variables such as age, height, and physical grade whose importance has been stressed by Professor Baird. At the same time I shall illustrate some of the techniques of social classification which are being tested in preparation for analysis against the obstetrical data.

The Registrar-General's method of social classification by occupation has already revealed, on the national scale, social class differences in age and parity, and in the stillbirth and infant mortality rates. It therefore seemed desirable to adopt this method in Aberdeen, to test its effectiveness in a small population in a well-defined but isolated area and also to study its usefulness when applied to variables such as height and physique not available in national statistics.

Table I shows the relationship of the Registrar-General's Social Classes to two selected variables—age and height.

TABLE I.—HUSBAND'S SOCIAL CLASS, WIFE'S HEIGHT AND AGE AT DELIVERY

Aberdeen Married Primiparæ 1949–1952 (*Excluding Twin Births*)

Description	Husband's social class											
	I	II	III	IV	V		I	II	III	IV	V	
	Number					Total	Percentage					Total
Wife's age:												
15–19 ..	1	6	192	86	72	357	1	2	11	20	20	12
20–24 ..	40	73	877	249	200	1,439	28	27	48	58	55	48
25–29 ..	66	109	503	67	66	811	47	41	28	15	18	27
30+ ..	34	81	233	31	27	406	24	30	13	7	7	13
Wife's height:												
Under 5′ 1″	14	19	403	102	111	649	10	7	22	24	31	21
5′ 1″–5′ 3″ ..	58	146	924	234	187	1,549	41	54	51	54	51	52
5′ 4″ and over	69	104	478	97	67	815	49	39	27	22	18	27
Total	141	269	1,805	433	365	3,013	100	100	100	100	100	100

In Social Classes I and II primiparæ tend to reproduce late but to be tall whilst in Classes IV and V they tend to be small but have their first child at an early age. Our clinical studies discussed earlier show that tall women (5 ft. 4 in. and over) are of better physical grade, have bigger pelves and a lower stillbirth rate than small women, and that younger women have easier labours than the older age groups.

The interplay of the three factors, social class, age and height is illustrated in Table II which shows the incidence of birth weights of 5½ lb. or less.

TABLE II.—THE INCIDENCE OF PREMATURITY (BIRTH WEIGHT 5½ LB. OR LESS) BY SOCIAL CLASS OF HUSBAND AND AGE AND HEIGHT OF WIFE

Aberdeen Married Primiparæ 1949–1951 (*Excluding Twin Births*)

Social class	Height			Age at delivery				Total	Number of women
	Under 5′ 1″	5′ 1″–5′ 3″	5′ 4″ and over	15–19	20–24	25–29	30+		
	Percentage of Prematurity								
I and II ..	12·1	3·9	4·0	—	3·5	2·9	8·7	4·6	410
III	10·4	8·0	5·4	7·3	7·5	8·9	7·3	7·9	1,805
IV and V ..	14·1	9·3	7·9	14·6	9·1	8·1	10·4	10·3	798
All classes ..	11·7	7·8	5·6	10·4	7·7	7·6	8·1	8·1	3,013
Number of women	649	1,549	815	357	1,439	811	406	3,013	3,013

Whilst there is a marked relationship between social class and prematurity this relationship is by no means straightforward for there exists an equally strong association with height within each social class. Whilst we have as yet insufficient cases to understand fully the effect of age the indications are that the prematurity rate among primiparæ is highest among those who are under 20 or over 30 years of age. The rate is particularly high among the very young in Social Classes IV and V, a group which contains a high proportion of small women of poor physical grade. This fact rather than extreme youth is probably responsible for the high prematurity rate.

The use of the Registrar-General's method of social classification therefore confirms and extends the results previously obtained by Professor Baird in his comparison between nursing home and hospital patients. But there are possible objections to the use of the Husband's Social Class in obstetrical research. In Aberdeen 50% of primiparæ conceive either before marriage or within three months of marriage so that at first sight the husband's occupation would seem unlikely to reflect the wife's social background and history. We require an index of a woman's total environment from birth to marriage so that this can be tested against physical condition, reproductive pattern and the outcome of pregnancy. As an approach to this I have used a combination of the social classes of a woman's father and husband; the former may be expected to reflect social conditions during upbringing whilst the latter describes the conditions of marriage and pregnancy. The composi-

tion and the size of these combined social classes and the order in which they are arranged are given in Table III and illustrated in Fig. 2.

TABLE III

Order of groups	Husband's social class	Father's social class	Number of cases
1	I and II	I and II	43
2	I and II	III–V	52
3	III	I and II	85
4	III	III	400
5	III	IV and V	264
6	IV and V	I–III	152
7	IV and V	IV and V	171
All groups			1,167

The order of these seven groups involves two major assumptions:

(1) That, whatever her class of origin, a woman's total environment is best judged by her husband's social class. This was based on preliminary work which showed that the occupation of the man a woman marries gives a surer indication of her social circumstances before marriage and of her personal characteristics than the occupation of her father.

(2) That within each Husband's Social Class the wives brought up in Social Classes I and II would have had a better total environment than those brought up in Social Classes III–V.

These seven classes were analysed against a number of factors selected to measure the quality of a woman's upbringing. These were the number of children in her family of upbringing, her school-leaving age and her pre-marital occupation. The index proved to be a good measure of environment for the seven classes arranged themselves quite clearly into the expected order (Table IV and Fig. 3). Thus, for example, of the women brought up in Social Classes I and II those who married into Social Class III (Group 3) came, in general, from larger families, had a shorter education and took less skilled jobs than those who married into Social Classes I and II (Group 1). And of the women who married into Social Class III those coming from Social Classes IV and V (Group 5) had a poorer environment than those coming from I and II (Group 3).

Having evolved an effective index of environment the next step was to discover how far these different environments were reflected in the woman's physical condition and her reproductive pattern. The results are shown in Table IV and illustrated in Figs. 4 and 5.

TABLE IV.—SOCIAL STRATIFICATION

Hospital booked married primiparæ Aberdeen 1950–51

Husband's social class	I and II		III			IV and V	
Father's social class	I and II (1)	III–V (2)	I and II (3)	III (4)	IV and V (5)	I–III (6)	IV and V (7)
Pre-marital environment:							
Average number of children in family of upbringing*	3·4	3·8	3·8	3·9	4·9	5·4	5·6
Left school aged 14 (%)	29	57	73	87	95	95	98
Wife's occupation semi-skilled or unskilled (%)	—	8	13	24	36	38	48
Physical condition:							
Under 5′ 1″ in height (%)	12	10	22	22	24	24	30
Under average physical grade (%)	15	22	18	33	43	47	53
Reproductive pattern:							
Aged 30 or over (%)	26	21	16	11	11	9	6
Conceived pre-nuptially (%)	12	21	14	21	30	41	40
Number of women	43	52	85	400	264	152	171

*Size of family is available only for 287 cases, the numbers in each group being 17, 6, 28, 75, 83, 29 and 49 respectively; the remaining items refer to hospital primiparæ delivered between July 1950 and December 1951 (1,167 cases).

Table IV shows that a woman's height and physical grade, and the timing of her first pregnancy are directly associated with the quality of her total environment. Broadly speaking, the girl born into a small family in Social Class III, who lives in good conditions, gets more than the minimum education and takes a clerical occupation, tends to be well grown and of good physical grade, to marry later and into a higher social class, and to plan the timing of her first pregnancy. The girl born into the same social class without the same social advantages tends to be small and of poor

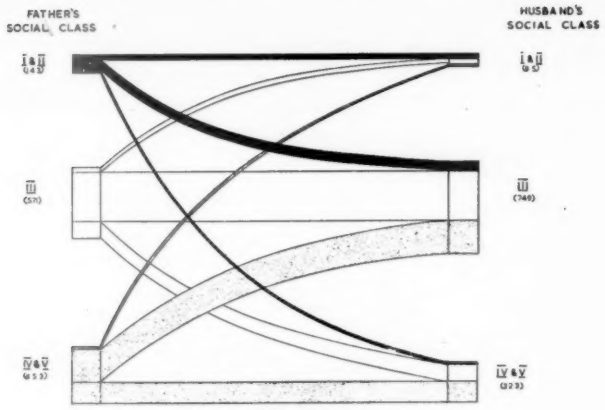

FIG. 2.
INTERMARRIAGE BETWEEN SOCIAL CLASSES.
Booked married primiparæ (Hospital Series 1950–51).

physique, to marry into a lower social class and to conceive before the age of 25, frequently before marriage. The smooth gradation shown in Figs. 3, 4 and 5 is most striking and lends strong support to this interpretation.

From these results two broad conclusions emerge:

(1) That the explanation of many obstetrical phenomena must be sought in the influences which have determined the mother's outlook and physique from an early age and not merely in the events of pregnancy itself.

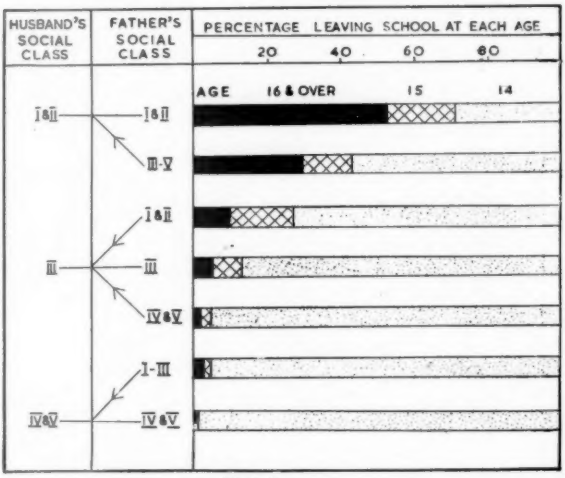

FIG. 3.
SOCIAL STRATIFICATION AND SCHOOL LEAVING AGE.
Booked married primiparæ (Hospital Series 1950–51).

(2) That Husband's Social Class is an effective tool in research into obstetrics not merely because it reflects the social conditions of pregnancy but because it is an equally good index of upbringing and of physique and health. This occurs because a woman of good physique with a good social background (whatever her nominal social class during upbringing) tends to marry into Social Classes I and II, whilst the woman of poor physique and poor social background tends to marry into Social Classes IV and V.

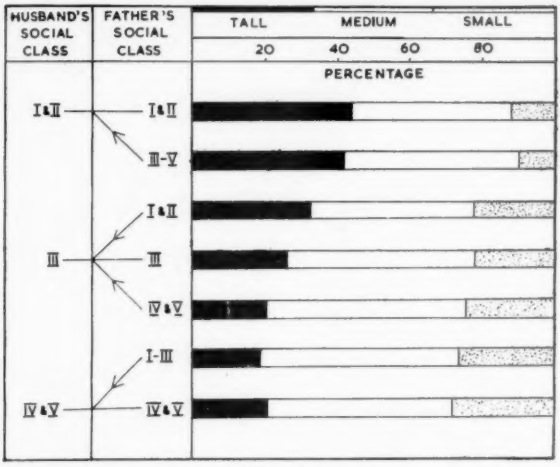

FIG. 4.
SOCIAL STRATIFICATION AND THE DISTRIBUTION OF HEIGHT.
Booked married primiparæ (Hospital Series 1950–51).

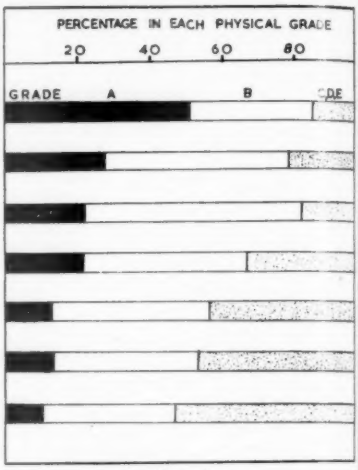

FIG. 5.
SOCIAL STRATIFICATION AND PHYSICAL GRADE.
Booked married primiparæ (Hospital Series 1950–51).

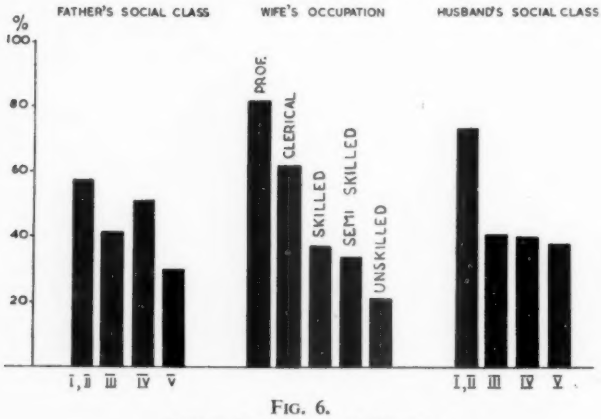

FIG. 6.
BREAST FEEDING AT 13 WEEKS.
Booked married primiparæ (Hospital Series 1950–52).
Random Sample (231 cases).

As a result of more recent work in Aberdeen it appears that, for the understanding of certain medical problems, the woman's pre-marital occupation alone may be an equally useful tool. This is illustrated in Fig. 6 which shows for three types of social classification the percentage of women breast feeding in hospital who were still lactating successfully at three months after delivery. The analysis by wife's occupation shows that the rate of breast feeding drops steadily from 81% among professional and technical workers to 21% among unskilled workers. The number of cases is small but this close relationship suggests that the reasons for breast-feeding failure, after it has been successfully established, may perhaps be most profitably sought in factors associated with the wife's occupation. This provides a useful starting point for further enquiry.

These methods of social classification are now being applied to the other branches of the enquiry to learn more about the interactions between the various social factors, for example, between social class, intelligence and nutrition, and between the social factors and the various biological factors,

for example between social class, emotional stability and difficult labour. And finally these many interrelated factors will be brought together to see how far they contribute to the successful or unsuccessful outcome of pregnancy and labour.

ACKNOWLEDGMENTS

We are grateful to the Matron of the Rubislaw Nursing Home and to the Medical Officer of Health for Aberdeen for information on nursing home cases and home confinements respectively; to Dr. A. M. Thomson and Dr. F. E. Hytten for advice and help with illustrations; to the field workers and members of the Almoner's Staff of the Maternity Hospital for the collection of data over the last three years and to Dr. J. N. Morris and Mr. H. A. Heady of the Social Medicine Research Unit, Medical Research Council, for criticism and advice.

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[*November* 21, 1952]

DISCUSSION: RESPIRATORY INFECTIONS IN CHILDHOOD

Dr. T. Anderson, Reader in Infectious Diseases, University of Glasgow.

A Study of Family Contacts

In 1943 it was pointed out that the effect of sulphonamides upon the mortality from pneumonia had been most striking in the middle-age groups but that in those in the first year of life and those over 45 years the effect had been less obvious. Table I shows the statistics for Glasgow during the

TABLE I.—STATISTICS IN RESPECT OF RESPIRATORY INFECTIONS IN GLASGOW: 1924–51, IN FOUR-YEAR PERIODS (AGE GROUP 0–1 YEAR)

Period	Population	Registered cases of pneumonia	Deaths from pneumonia and bronchitis	Measles registered		Pertussis registered	
				Cases	Deaths	Cases	Deaths
1924–27	91,255	4,265	2,728	2,571	385	4,813	773
		(47)	(30)	(28)	(4·2)	(53)	(8·5)
1928–31	83,308	4,073	2,403	2,785	376	2,981	599
		(49)	(29)	(33)	(4·5)	(36)	(7·2)
1932–35	79,233	5,022	2,423	1,954	227	2,336	366
		(63)	(31)	(25)	(2·9)	(29)	(4·6)
1936–39	79,348	4,028	1,890	2,324	192	2,026	308
		(51)	(24)	(29)	(2·4)	(26)	(3·9)
1940–43	76,203	4,806	1,660	1,486	91	1,531	218
		(63)	(22)	(20)	(1·2)	(20)	(2·9)
1944–47	83,272	3,860	1,060	1,291	39	1,247	93
		(46)	(13)	(16)	(0·5)	(15)	(1·1)
1948–51	81,376	2,329	531	1,040	19	1,715	43
		(29)	(7)	(13)	(0·2)	(21)	(0·5)

The figures in brackets are registered case-rates or death-rates per 1,000 infants 0–1 year.

last thirty years for the age group 0–1 year in regard to pneumonia, measles and pertussis. The age-specific death-rates for these diseases show that up to the four-year period 1940–43 there was little

change apparent in the death-rate for pneumonia. In the two succeeding periods, however, a very marked reduction has taken place, so that the rate for the last period is about one-quarter to one-fifth of that previously prevailing. Comparison with measles and pertussis shows that the mortality from these diseases has followed a similar pattern to that for pneumonia, although here the reduction is more uniform from the beginning of the period. The pattern of the curves, the slower response of pneumonia to the effect of chemotherapy and the fact that a reduction in mortality from pertussis has been continuous throughout the thirty years, seem to raise the question of how much of the observed reduction in mortality is due to factors other than chemotherapy.

The following study of the background of cases of pneumonia in the age group 0–2 years was made during the winter of 1950–51. During the period of the study 77 children were admitted to the ward. From these children, typable pneumococci were isolated from 43 (56%). The presence of pneumonia was confirmed clinically and/or radiologically in 46 (60%); in a further 10 the diagnosis was severe bronchitis or bronchiolitis; while in the remaining 21 the lungs were not heavily involved and the infection was confined to the upper respiratory tract.

From this group of 77 children, 245 contacts were examined. The examination of these contacts for the presence of typable pneumococci gave the results shown in Table II. The results obtained

TABLE II.—COMPARISON OF PNEUMONIA CONTACTS AND "CONTACTS" OF NEW-BORN BABY

	Pneumonia contacts			Sample of single visit to baby contacts		
	Pneumococci isolated			Pneumococci isolated		
Age group	Yes	No	Total	Yes	No	Total
0– 5 years	36 (72)	14	50 (100)	72 (62)	44	116 (100)
–15 years	28 (65)	15	43 (100)	42 (49)	44	86 (100)
–25 years	10 (42)	14	24 (100)	2 (7)	25	27 (100)
26 + years	51 (40)	77	128 (100)	28 (18)	129	157 (100)
Totals	125	120	245	144	242	386

The figures in brackets are percentages.

in this group of pneumonia contacts may be compared with a different population which was examined during the same period of time. This second group was chosen because of the occurrence of a birth in the family. Only the result of the first visit to the home is recorded for a random sample of these families, so that the results are comparable. It will be observed that for all age groups the carrier rate in the pneumonia contacts is higher than for the baby contacts. The differences are formally significant only over the age of 16 years.

The next step was to find out if the family carried the same type as the patient. This aspect was complicated by the fact that the types isolated from the affected babies were those commonly present in healthy persons. Thus, from the babies the commonest types isolated were: 23, 6, 19, 21 and 4; while from the contacts the types isolated most frequently were: 23, 6, 10, 7, 33, 18, 21, 22 and 29. It was, therefore, decided to concentrate upon the types 1, 2, 5 and 7 which are less frequently isolated from normal persons, are usually credited with greater invasiveness and have been designated the "epidemic" types. There were 8 such cases in the series of 77 babies—type 1 (4), type 2 (1), type 5 (1) and type 7 (2). The results of the examination of the contacts of these babies is shown in Table III in which the figures are also included of a study made of the contacts of 10 adult pneumonias from whom types 1 or 2 were isolated. In both series the results are clearly disappointing.

TABLE III.—RESULTS OF EXAMINATION OF CONTACTS OF PNEUMONIA DUE TO TYPES 1, 2, 5 AND 7

	Contacts of pneumonias 0–2 years types 1, 2, 5 and 7			Contacts of pneumonias 25+ years types 1 and 2		
Age group	Total	Pneumococcus isolated	Homologous type isolated	Total	Pneumococcus isolated	Homologous type isolated
0– 5 years	12	8	0	5	5	2 (one type 1) (one type 2)
–15 years	13	9	2 (both type 7)	9	5	0
16 + years	24	9	1 (type 2)	23	12	1 (type 1)
Totals	49	26	3	37	22	3

It would thus seem that although the home contacts of baby pneumonia patients, more especially those over the age of 16 years, show a high pneumococcal carrier rate, this is largely composed of heterologous types similar to those found in a random sample of the population.

Attention may now be directed to the occurrence of respiratory infection in the pneumonia contacts. The relevant figures are shown in Table IV. For comparison the contacts of the newborn

TABLE IV.—PRESENCE OF RESPIRATORY INFECTION IN FAMILY CONTACTS OF PNEUMONIA (0–2 YEARS), COMPARED WITH "BABY CONTACTS"

Age group of contacts	Pneumonia contacts			Random sample from baby survey	
	Total	No illness reported	Recent (–14 days) respiratory infection	Total	Recent (–14 days) respiratory infection
0– 5 years	50	37	13—11 U.R.D. (26) 1 bronchitis 1 pneumonia	45	6 U.R.D.
6–15 years	43	36	7— 5 U.R.D. (16) 2 severe rhinitis and laryngitis	24	4 U.R.D.
16–25 years	24	19	5— 4 U.R.D. (21) 1 bronchitis	4	0
26 + years	128	93	35—22 U.R.D. (27) 3 tonsillitis 9 bronchitis 1 pneumonia	56	3 U.R.D.
Totals	245	185	60	129	13

N.B.—The figures in brackets are percentages of the total in that age-group. U.R.D. indicates an illness of the nature of a common cold with symptoms and signs referable to the upper respiratory tract.

babies have been used and a random selection of the results of the first visit to the home is given. It will be observed that there was, in the pneumonia contacts, a high incidence of respiratory infection. Thus, in the pre-school and school population 20 out of the total of 93 had been affected; and in those over 15 years there was a history of such illnesses in 40 out of 152. This apparent difference with age is not formally significant. The comparison with the control series, however, suggests that there is a significant difference. When age is discounted the rates in the pneumonia contacts and baby contacts are 24·5% and 10·1% respectively.

Thus three features emerge from this study of contacts of acute respiratory infection in childhood. First, the pneumococcal carriage rate is higher in the older age groups; second, the higher carrier rate is not due to an obvious increase in carriage of the homologous type; and, third, the incidence of non-pneumonic acute respiratory disease is much higher.

These findings might support a view that an important precedent factor in the causation of respiratory infection and pneumonia in the first year of life is a family outbreak of infection similar to the common cold. The effect of this respiratory infection may be to extend the colonization by pneumococci of the respiratory tract of the older members of the household, so that the child is exposed to an increased dose of organisms.

Dr. J. B. Landsman, Lecturer in Infectious Diseases, University of Glasgow.

A Study of the Pneumococcal Carriage in Infancy

The study reported was carried out during 1950 and concerned 99 infants examined repeatedly in their homes from birth up to a maximum of one year, with a view to determining whether the appearance of pneumococci was associated with respiratory symptoms. All the visits—a total of 920—were paid by one fully trained nursing sister, to whom notification was made of a birth conducted by a midwife within certain districts of Glasgow. Pernasal and throat swabs were obtained from mother and baby within one and a half to forty-eight hours of birth and from other members of the family present at the first visit. Subsequent visits were paid weekly, then fortnightly and later monthly, at which swabs were taken only from the mother and baby or from others not previously examined. At all visits attention was paid to a history of respiratory infection in any member of the family. Bacteriological examination of the swabs was directed to the identification and typing of pneumococci by culture on blood-agar and gentian violet blood-agar plates, and subsequently by the use of capsule tests, optochin sensitivity and, if necessary, mouse inoculation.

Pneumococcal carriage was assessed by weeks of age and in regard to the presence of respiratory symptoms. Since these results were obtained from repeated visits to the same infants, it was difficult to express them in the form of "rates". They were presented on the basis that each infant was "new" at each visit; i.e. that a sample of babies aged 4 weeks, 8 weeks, 3 months, &c., was examined, to a total of 920, although, in fact, only 99 babies were studied.

Of these 99 infants 62 (62·6%) carried a pneumococcus at some time during the period of observation, which for the series ranged from birth to a maximum of 47 weeks (1–21 visits). The carrier rate

among the babies' "contacts" (principally their mothers) was 36·1% and it therefore seems that in the young age group the carrier rate tends to be higher. Pneumococci were isolated from the infants at 273 of the total of 920 visits (29·7%). The carrier rate at the first week of age was 15·2% and this rose to 30% at the third week, thereafter remaining fairly constantly between 35 and 40% (*see* Table I). In all, 308 pneumococcal types were isolated, including 33 of the available 46 types. The types most frequently encountered among the infants were 19, 6, 23, 11, 14 and 10, and among the contacts these same types were found most often but in slightly different order, namely, 6, 19, 23, 11, 10 and 14. There was no suggestion that a particular type or types had an association with the age or sex of the infant, or with the season of the year.

TABLE I.—CARRIAGE OF PNEUMOCOCCI BY AGE AND OCCURRENCE OF INCIDENTS*

Age (weeks)	Total in group	Carriers	Incidents	Incident with pneumo.	No pneumo. incident	Persons without incident	With pneumo.	Without pneumo.
1– 5	271	63 (23·3)	49 (18·1)	14 (28·6)	35	222	49 (22·1)	173
6–10	94	32 (33·9)	20 (21·2)	9 (45)	11	74	23 (31·1)	51
11–16	114	48 (41·9)	32 (28)	18 (56·2)	14	82	30 (36·1)	52
17–24	158	53 (33·5)	50 (31·6)	17 (34)	33	108	36 (33·3)	72
25–32	96	40 (41·6)	43 (44·7)	20 (46·6)	23	53	20 (37·8)	33
33+	88	34 (38·4)	41 (46·3)	18 (43·9)	23	47	16 (34·1)	31
Totals	821	270	235	96	139	586	174	412

* 3 babies carried pneumococci at birth; type 19 (found in siblings); type 24 (not found in family), and an untypable pneumococcus (types 4 and 19 found in a sibling).

Figures in brackets represent percentages.

99 visits to newborn under 1 week not included.

The appearance of the "epidemic" types—1, 2, 5 and 7—and type 3, often associated with severe infections, was noted. Type 1 was not found in any of the infants although it was isolated from some of their contacts. Types 2 and 3 were each isolated from 3 babies and types 5 and 7 were each found in one baby. A study of the histories of these 8 infants failed to show that the appearance of the epidemic types was in any way connected with respiratory infection.

Attention was paid to respiratory symptoms occurring in the infants; 235 such "incidents" were noted and of these the majority were mild upper respiratory infections. 70 of the 99 infants suffered from respiratory symptoms and in 11 of them (producing 13 incidents) the symptoms were of sufficient severity to be considered by the general practitioner in attendance as cases of croup, bronchitis or pneumonia. Only 2 of the infants were admitted to hospital although in neither of these were the symptoms unusually severe. Scrutiny of the bacteriological results in these 11 infants did not suggest that the illness resulted from the acquisition of a new pneumococcal type.

Considering the pneumococcal carriage in those infants who suffered a respiratory "incident" and in those who remained well, it was found that the carrier rate appeared higher in those with "incidents" (40% as compared with 30%). Because of the fact of replication of visits, these results do not lend themselves to statistical treatment. It is suggested, however, that the difference in these two groups is significant.

It might be argued, therefore, that the presence of an infection such as the common cold produces local changes which favour multiplication of the pneumococcus, so that the examiner has an increased chance of identifying the carrier.

Certain factors have been assumed as contributing to the occurrence of pneumonia in infancy and among these are overcrowding and undernutrition. In the presence of these and the lowering of resistance which undernutrition may encourage, it has been suggested that the pneumococci commonly present in adults and older children when transferred to the infants have been enabled to invade and produce illness. Yet here we have been dealing with infants born into homes which in many cases were very far from satisfactory in every way. Overcrowding and lack of care were manifest and there is no doubt that the pneumococci were present, yet only 13 instances of obvious respiratory distress occurred and only 2 infants reached hospital. Neither was seriously ill when seen on admission and there were no deaths.

We would suggest, then, that an unknown factor—possibly viral in nature—is the principal contributory agent in the production of infant pneumonias.

ACKNOWLEDGMENTS

These studies were carried out with the aid of a grant from the Medical Research Council. The work was of a co-operative character and we would particularly record our appreciation of the assistance of Dr. A. M. T. Drimmie who was responsible for the examinations of the pneumonia patients and Miss J. P. Fernie whose patient efficiency made the home studies possible. We are also indebted to Miss M. Knox of the City of Glasgow Public Health Department for supplying the Glasgow figures. Dr. W. P. D. Logan has given most valuable statistical advice.

Dr. R. L. Mendez, Medical Research Council Scholar, and **Dr. M. Likar:**

Respiratory Infections among Families in Paddington

Since mid-March of this year a team of workers from the Bacteriology and Pædiatric Departments of St. Mary's Hospital Medical School, with help from the Epidemiology Department of the London School of Hygiene, has been carrying out an epidemiological investigation into respiratory infections among families in the Paddington area. The main purpose of this study is to find what effect environmental factors such as overcrowding may have on the incidence and spread of respiratory infection among families of uniform size—namely, three children, at least one of whom is under five years of age, and two parents. Detailed laboratory investigations of the upper respiratory flora are being made and are being correlated with clinical and epidemiological data, but in this preliminary report only some general analyses of the bacteriological findings are presented.

Between March 17 and October 10, 1952, 2,217 pairs of pernasal and throat swabs were taken from 50 families—79 pairs from 9 children aged 0–1 year, 617 pairs from 72 children aged 1–5 years, 695 pairs from 79 children over 5, 485 pairs from 50 mothers and 341 pairs from 50 fathers. 10 children are represented twice as their first or fifth birthdays necessitated their being transferred to the next age group. These are the totals on which all the results are based except in the case of the capsulated hæmophili, and findings are given as the percentages of the total swabs examined in each age group.

Coagulase-positive staphylococci.—From pairs of swabs taken from the under-1 group the recovery rate was 24%, from pairs taken from the 1–5 group the recovery rate was 31%, from those taken from the over-5 group the rate was 48%, while from the mothers the rate was 43% and from the fathers 33%.

Thus the school-age children showed the highest recovery rate, and it will be noted that the maternal rate was almost as high. This high rate may be related to a greater opportunity for cross infection in the school environment, and the mothers, in turn, may be more liable than the fathers to pick up staphylococci from their children. These figures are roughly parallel with Cunliffe's (1949) findings on the carrier rates of coagulase-positive staphylococci in the anterior nares in similar age groups.

Pneumococci.—In the case of pneumococci the highest recovery rates were from swabs taken from the younger children—38% from the under-1 group and 40% from the 1–5 group—while the rate for the over-5 group was 26%, and for the mothers and fathers 16% and 17% respectively.

Hæmolytic streptococci.—Here the rates were almost the same for all groups—10% for the under-1 group, 13% for the 1–5 group, 14% for the over-5 group and 12% for both mothers and fathers.

Capsulated hæmophili.—The recovery rates were 3% for the children and 3% for the adults. (These results were based only on 417 pairs of swabs from the children and 260 pairs from the adults, as a full set of Pittman antisera was not available until August.)

We thought it would be interesting to see if the recovery rates for pneumococci and hæmolytic streptococci varied from swabs taken during respiratory infection and from swabs taken when individuals were well. (For the purpose of this paper the term "respiratory infection" means any infection of the upper, middle or lower respiratory tract.) Considering pneumococci, in all age groups a higher proportion of swabs taken during infection grew pneumococci than did those taken when no infection was present. However, when hæmolytic streptococci were considered it was found that there was little difference between the two rates in all groups. Indeed, in the children aged 1–5 and in the adults, a higher proportion of swabs taken when no infection was present grew streptococci.

Distribution of coagulase-positive staphylococci and of pneumococci between the nose and throat.—In all groups, staphylococci were grown only from the pernasal swabs about twice as often as they were grown from both pernasal and throat swabs. There were few occasions when staphylococci

were grown from the throat swabs but not from the pernasal swabs—never more than 5% in any group. These results conform with other evidence that the nose is the natural reservoir for the staphylococcus.

The distribution of pneumococci was quite different. Whereas in the children the majority of pneumococci were found in the nose only—60% in the under-1-year-olds, 65% in the 1-to-5-year-olds, 54% in the over-5-year-olds—in the case of the mothers and fathers over 60% of the pneumococci were grown from the throat swabs only. This may mean that pneumococci colonize a greater part of the postnasal space in children than in adults, or simply that pernasal swabs reach the back of the nose more easily in children and that therefore pneumococci are more easily picked up.

Hæmophilus influenzae types.—From the 417 pairs of swabs taken from children, 13 Pittman strains were isolated and the different types occurred as follows—Pittman b 5 times, Pittman d, e and f twice each, and types a and c once each. Dawson and Zinnemann (1952) in Leeds found that types e and f were commonest, although Alexander (1943) in New York found type b to occur most often. There may well be local variations in the relative incidence of different types as Dawson and Zinnemann (1952) suggest. Type b was never recovered from the adults, although type e was recovered four times, type d three times and type f once. This absence of type b in adults agrees with Straker's (1945) findings. There was no positive correlation between the presence of respiratory infection and the carriage of Pittman-type hæmophili.

Pneumococcus types.—From the 2,217 pairs of swabs 606 strains of pneumococci were recovered, of which 33 were untyped. However, none of these 33 strains were put into mice. The commonest types were 6, 19, 8, 14, 23 and 11 in that order of frequency. The first 5 of these types have been found as common commensals among children in many parts of the world. Types 1, 2 and 3 were rarely found and did not occur at all between the end of May and early October. When they did occur they were not related to any particularly severe form of infection. All the other types were distributed fairly evenly over the seven-month period. On 28 occasions 2 different pneumococcus types were recovered simultaneously from the same person, and on one occasion 3 different types were found.

It must be remembered that these data represent a seven-month period only and that therefore a comparison of seasonal variations is not yet possible. The families in the survey are being divided into various sub-groups according to different environmental factors, with particular reference to overcrowding, but we have not, as yet, enough material to compare results in these different groups. We have been surprised at the amount of respiratory infection present in our families even during the summer months, and by the end of next year we should know considerably more about these infections and be able to enlarge and elaborate upon the results given in this interim report.

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Section of Medicine

President—Sir ALUN ROWLANDS, K.B.E., M.D., F.R.C.P.

[*October* 28, 1952]

DISCUSSION ON INTESTINAL GRANULOMATA AND RETICULOSES

Dr. Cuthbert E. Dukes: The word "granuloma" is used to describe a tumour-like swelling resulting from an exaggerated inflammatory or reparative process.

It differs from a true tumour, or neoplasm, in that it passes through various phases and may ultimately retrogress spontaneously and disappear, though usually leaving a fibrous scar. Most granulomata are known to be the result of chronic infection with a pathogenic organism either bacterium, protozoa or virus; but chemical irritants, repeated trauma and foreign bodies may also give rise to granulomata.

Many different varieties of granuloma are known to occur in the intestinal tract but none are common.

[Pictures were then shown of the varieties which Mr. Dukes had met with in his work in the pathology department of St. Mark's Hospital, London.

These included granulomata caused by tuberculosis, syphilis and actinomycosis; amœbic dysentery and bilharzia; granulomatous lesions associated with chronic ulcerative colitis, Crohn's disease and segmental colitis; granulomata resulting from foreign bodies, trauma and the injection of non-absorbable oils.]

Dr. Dukes continued: It is not easy to define the term reticulosis, but it is certainly a very convenient label to attach to obscure swellings of lymphoid and reticular tissues. The word "reticulosis", like charity, may be said "to cover a multitude of sins".

Lesions of the intestine due to reticulosis are even rarer than granulomata.

The three varieties which I have studied personally, are simple lymphoma, lymphosarcoma and reticulum-cell sarcoma.

[Dr. Dukes then showed a series of lantern slides illustrating the gross character and histology of the intestinal granulomata and reticuloses referred to above.]

He concluded as follows: Pathological investigations in relation both to the diagnosis and ultimate prognosis of intestinal granulomata and reticuloses are of primary importance.

Dr. W. Trevor Cooke: In considering non-specific granulomata of the intestinal tract, it is difficult to add much to the store of clinical observations amassed by Crohn (1949) but some of the problems encountered can be discussed—from the physician's viewpoint—from a more limited experience of 70 patients.

Crohn's definition cannot be bettered: "Regional ileitis is a non-specific chronic recurrent granulomatous disease affecting mainly young adults and characterized by a necrotizing, ulcerating inflammatory process, one in which cicatrizing elements in long-enduring cases are an important feature." As the result of careful clinico-pathological correlations, it has become evident that acute, subacute and chronic regional ileitis are differing degrees of the same intestinal reaction, whatever the factor initiating that process may be. In many patients the pathological picture is quite characteristic but in others the histological picture is indeterminate, so that many consider that regional ileitis is a clinical but not a pathological entity. The complete resolution of the acute ileitis is probably the rule rather than the exception, while it can be accepted that even relatively rigid and swollen lengths of intestine can resolve completely; though when any great length of intestine is involved, the process is more likely to progress through the subacute to the fibrosed state.

FIG. 1.—Intestinal X-ray (Raybar) showing generalized dilatation with some widening of the valvulæ conniventes.

FIG. 2.—Intestinal X-ray (Raybar) showing progression of the lesion with areas of destruction of the mucosa and commencing stenosis.

FIG. 3.—Intestinal X-ray (Raybar) showing extensive stenosis of the ileum.

S. W., a 14-year-old girl, suffered with diarrhœa and progressive loss of weight for nine months (Fig. 1). Exploratory laparotomy revealed generalized enlargement of the mesenteric glands which showed a granulomatous reaction on section: the intestine was mildly œdematous, becoming hyperæmic on handling. There was a gross fat absorption defect at this time. One year later the picture of intestinal involvement was much more marked (Fig. 2) and the next picture (Fig. 3) taken fifteen months later, when attacks of abdominal pain and vomiting had begun to be frequent, shows the stenotic phase. Laparotomy now revealed 3 foot of the upper ileum stenosed rigid and the mesentery so contracted that the only course possible was to by-pass the affected segment. Therapeutically it was effective and she is now back at school weighing 9 st., just below her weight three years previously. It is of interest that gross fat absorption at the time of the first picture gradually improved over the next two and a half years until at the time of the second operation it was essentially normal.

On the other hand, it is possible for the process to become completely stationary even when long lengths of the intestine are affected (Cutler, 1939; Cooke, 1952). One must conclude that the clinical course in any given patient is at present unpredictable. Following operation, recurrence rate is high in our patients even though the time of follow-up has been relatively short. Once the diagnosis has been made the patient must remain under medical supervision.

The diagnosis for a physician is difficult. The first essential is an awareness of the varied ways in which regional ileitis may present and the possibility of its presence in many obscure abdominal problems. Crohn (1949) has stressed the frequency of diarrhœa and relatively long periods of prodromal symptoms, terminated by subacute intestinal obstruction or the formation of a mass or fistula. These mild symptoms of intermittent diarrhœa, malaise, loss of weight, and occasional pyrexia had lasted between one and five years in more than half of a series of 183 patients he reported. When pain does occur, it is often related to food so that peptic ulceration may be simulated. This is a real hazard, for the diagnosis may be missed when attention is directed only to the stomach. In 3 of our patients, a gastric ulcer was present in addition to the terminal ileitis. When pain is present, it is usually peri-umbilical in distribution though it may be relatively mild and no more than might be expected during an attack of diarrhœa caused by some trivial factor. When symptoms of obstruction, perforation or fistula formation become apparent, the

diagnosis is readily made, though by that time extensive secondary changes may have made treatment difficult.

Diagnosis depends to a great extent upon the information obtained from X-rays. Recurrent abdominal pain, in association with intermittent diarrhœa and loss of weight, should always lead to careful examination of the small intestine and successful examination requires much time-consuming work. Since the main brunt of regional ileitis falls upon the terminal ileum, a good knowledge of the variations of the normal terminal ileum is required. On the whole, we have had more successes from barium follow-through studies with frequent screenings than from barium enemas. but radiological diagnosis is by no means infallible. Even with the utmost patience, serious lesions may not be detected, and, when abnormalities are detected, radiology gives no absolute indication as to the ætiological factor. It may, therefore, be necessary to advise exploratory laparotomy to confirm the nature and extent of the lesion. While a barium emulsion which flocculates only with difficulty, such as "Raybar", has many advantages, and is probably the most satisfactory to use in these conditions, certain reservations should be made.

On reviewing our X-rays the majority of which were made with a flocculating barium mixture, it was found that some patients would show a perfectly normal intestinal pattern proximal to the lesion whilst others might show a generalized flocculating deficiency pattern, even though the chronic lesion might not be greatly different in the two groups. The subsequent course in the two groups appeared different. Those in whom flocculation was extensive ran a much more troublesome course with the eventual formation of multiple strictures elsewhere in the intestinal tract; some of them have died. This observation needs further confirmation but it is, at any rate, true that the extent of macroscopic involvement is no guide to the extent of microscopic involvement. For my part, I regard the presence of extensive flocculation as an indication of the severity of the process and of poor prognosis.

As to other laboratory aids in diagnosis such as blood counts, fractional test meals, blood chemistry, fat balances, glucose tolerance tests, and occult blood tests, none of them are significant for they may be normal or abnormal in any given patient.

Jejuno-ileitis.—The characteristic features are diarrhœa of acute or gradual onset, loss of weight, intermittent pyrexia and abdominal pain of variable intensity. The fæces contain much fat, while macrocytic anæmia and low serum proteins may develop. In these with the most extensive involvement, weight loss and dehydration may be extremely severe. The process may resolve completely or proceed to a chronic stage with the formation of multiple strictures. In the absence of laparotomy the condition may be difficult to differentiate from idiopathic steatorrhœa, though the higher incidence of abdominal pain without gross distension favours jejuno-ileitis. In many patients the radiological picture is characteristic (Fig. 2). *Enterocolitis* assumes special importance in diagnosis in view of the increasing number of patients with ulcerative colitis subjected to surgery. The clinical picture is dominated by diarrhœa and as Crohn *et al.* (1932) pointed out, superficially it may simulate ulcerative colitis. The process in ulcerative colitis, however, tends to spread upwards from the sigmoid whereas in ileocolitis the primary lesion is in the small intestine and the colon is secondarily involved. The entity sometimes described as right-sided colitis falls into this latter group.

In mild cases, the principal complaint is 4 to 5 loose and often pale stools a day. Mucus may be obvious though grossly bloody stools are rare. The cells are few and fatty acid crystals frequent. In the early stages constitutional upsets are minimal but radiological examination reveals changes in the terminal ileum, usually dilatation, poor motility and changes in the mucosal pattern. The colon shows smooth outline and reduction of haustration similar to that described in mucous colitis. Examination of fat absorption shows mild defects. With persistence of the disorder, the colon takes on more permanent changes in the ascending and transverse colon. Sigmoidoscopy reveals a red velvety mucous membrane without ulceration, different to the appearance in ulcerative colitis though easily mistaken. Eventually, the full steatorrhœa syndrome may develop: macrocytic anæmia, low serum proteins, splenomegaly and gross impairment of fat absorption. Colectomy in such cases carries a severe risk (Brooke and Cooke, 1951).

Whipple's disease (intestinal lipodystrophy, lipogranulomta) must be considered in relation to the groups already considered. The disorder has been reported predominantly in middle age. Symptoms usually have been present for more than a year. Abdominal symptoms are indefinite, although patients may have moderately severe abdominal pains leading to laparotomy. Progressive loss of weight, anæmia, weakness, lassitude and frequently a fatty diarrhœa are prominent. Migratory arthritis, low blood pressure and pigmentation are other findings. Anatomically the principal lesions are lipogranulomatosis in the mesenteric lymph nodes, and, in many patients, the finding of foamy macrophages in the intestine.

An important feature to note is that the diagnosis is made by surgical biopsy or autopsy; that is to say the reported cases are a highly selected series. Approximately 50 patients have been reported since Whipple's description in 1907: even so it has already become evident as is shown by the review given by Hendrix *et al.* (1950) that the clinical picture is far from uniform. Furthermore, both Russo (1952) and Avery Jones and Paulley (1949) suspect that the condition is very much more frequent than is commonly accepted, suggesting that it masquerades as atypical Addison's disease, various mesenteric lymphadenopathies, nutritional deficiency states, sprue syndromes and carcinoma of the pancreas without necessarily coming to autopsy.

Our experience suggests that this is indeed the case and it is also evident that surgeons and pathologists may mistake the condition for tuberculosis, carcinomatosis or reticulosis.

A pertinent example of this condition was a 56-year-old woman whom we were able to follow until her death four years later from bronchopneumonia. The relevant details of the history were similar to those already given, and the findings comparable to many patients with idiopathic steatorrhœa in that she had a resistant macrocytic anæmia and excess fat in her stools. Owing to recurrent abdominal pain, laparotomy was undertaken to define the nature of mesenteric glandular enlargement which had previously been palpated. The nature and appearances of abdominal glands convinced two very experienced surgeons that tuberculosis was present. At autopsy a year later it can readily be appreciated that this indeed seemed the most likely diagnosis (Figs. 4 and 5). The histology, however, was not that of tubercle nor could the tubercle bacillus be cultured.

FIG. 4.—Intestines and mesentery at autopsy showing the enlarged mesenteric glands.

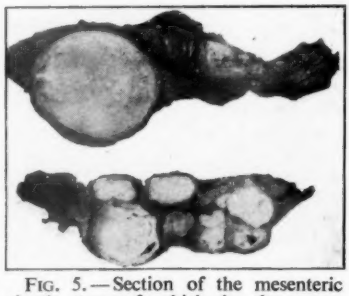

FIG. 5.—Section of the mesenteric glands—two of which in the upper specimen have been emptied of material leaving a glistening smooth capsule.

As a result of further study of mesenteric glands, for which I am indebted to Dr. J. L. Stafford, certain points emerge. The first is that careful examination of caseous or calcified glands did not show the histological evidence of tuberculosis in some 30 or 40 cases that were examined. The second is that all stages of granulomatous reaction with or without necrosis and reactive fibrosis, with or without cystic dilatation or engorged lymphatics can be found in many differing clinical conditions and bearing no apparent relationship to the disorder from which the patient might be suffering. In other words, enlarged mesenteric glands with granulomatous reaction are not the specific result of a single clinical entity but rather they are the end-result of many different stimuli, bringing about reactive changes, fibrosis or necrosis, in the lymph glands.

If this should be so then the changes found in the intestinal wall and the lymph glands may be regarded as being dependent upon certain factors amongst which are the nature of the exciting agent such as glycoproteins, products of fat breakdown or infection, the duration of that stimulus and the time since that stimulus was last applied and, set against this, the natural reparative action of the tissues themselves. Theoretically cases might be found with the maximum pathological findings in the intestinal wall with little or none in the lymph glands and, vice versa, occasional cases will be found in which the lymph glands simulate the characteristic findings of lipogranulomatosis, whilst the intestines show the findings of jejuno-ileitis.

Avery Jones and Paulley (1949) have already made this suggestion that Whipple's disease is a terminal phase of jejunitis and that such jejunitis is possibly a non-specific inflammation of hyperæmic œdematous mucosæ. There is no evidence as to what is the cause of these non-specific granulomata. Experimentally it is evident that substances absorbed from the gut can produce all the changes and the degrees of change that we have just surveyed (Chess *et al.*, 1950; Reichert and Mathes, 1936). From the clinical aspect I suspect that there are many differing factors, amongst which must be numbered faulty fat and protein absorption, local trauma and infection, to set in motion factors which give rise in differing degrees to changes in either the intestinal wall or lymph glands.

Treatment can only be symptomatic since the ætiology is unknown and must be directed towards the maintenance of nutrition which, in its turn, means the control of diarrhœa with or without steatorrhœa and the control of the anæmia which may be macrocytic or that due to blood loss. The adoption of a high protein-low fat diet seems the best to keep the patient comfortable and extra fat tends to aggravate his symptoms. Any persistent diarrhœa leads to the loss of electrolytes and any disorder that is associated with marked weight loss leads to diminution in electrolyte reserves, in particular those of potassium. Recognition of this fact will lead to more immediate good results and the avoidance of ileus after resection. Furthermore, most patients who have had resections tend

to have three to four loose stools per day and tend to deplete themselves of electrolytes: such patients are liable to develop a low potassium syndrome in all its guises: muscle weakness, mental disturbance and marked weight loss following any exacerbation of their diarrhœa or intercurrent infection. Hence, it is a wise precaution to administer extra potassium salts by mouth. Periods of adequate rest in bed even for months at a time play a real part in allowing reparative processes a fair chance.

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Mr. E. C. B. Butler: *Surgical Management of Certain Granulomata of the Intestine.*

REGIONAL COLITIS: ACUTE AND CHRONIC

Acute ileitis is probably more common than a study of Dr. Crohn's book (1949) would have us believe; his personal series amounted to 16 cases, only 4 of which subsided without further trouble. The records of the last 40 cases of regional ileitis which have been operated upon at the London Hospital show that 9 of these were classified as acute. In every case operation was performed for supposed acute appendicitis and in no case did the history extend back further than one week.

The treatment carried out on the 9 acute patients was as follows: 1 immediate resection, 1 ileo-transverse colostomy, 5 appendicectomies and the abdomen closed in the remainder. All survived. None of these patients has been readmitted to the London Hospital. Although a follow-up has been impracticable owing to the war it is reasonable to assume that most of them have had no further trouble.

The history of the patient who had an immediate excision was as follows:

Boy, aged 12. Admitted in 1936 with five hours' history of acute abdominal pain and vomiting. Diagnosed as acute appendicitis.

Operation (Mr. Henry Thompson for Mr. Russell Howard) showed a normal appendix and an acutely inflamed thickened lower ileum. Immediate resection and anastomosis was performed. The child remained healthy until 1939 when he was lost trace of.

Pathological report.—Subacute regional ileitis differing only from the usual chronic variety by the absence of fibrous tissue. This patient had no abdominal symptoms before his admission yet the pathological report indicated that his lesion was probably of several weeks' duration.

It seems evident that many of the so-called acute cases are already fairly advanced by the time they come to operation; it is this group which may give trouble if not treated by excision or exclusion operations; the true acute cases often resolve and give rise to no further symptoms.

[Unfortunately, at present, it is difficult to tell one variety from another at laparotomy, but I think in doubtful cases radical surgery is unjustifiable since the infection may well subside if left alone.]

Appendicectomy has no effect on the course of the disease but is permissible provided that the cæcum is not involved in the infection. There is no strong evidence to indicate that appendicectomy favours the incidence of future fistula formation in the acute case, although in the chronic or subacute stages of the disease appendicectomy has a poor record since quite a number of these patients subsequently develop a fæcal fistula. These fistulæ, however, usually come from the diseased ileum rather than from the stump of the appendix and it is probable that it is the laparotomy and not the removal of the appendix which is responsible, as the inflamed loop of ileum becomes adherent to the peritoneal scar.

Chronic ileitis.—The indications for surgery in this condition are well known: repeated colic, persistent anæmia, toxæmia or fistula formation; to these must be added the large group in whom a pre-operative diagnosis has not been made but who come to operation because of their symptoms. Three types of operations have been carried out:

(1) *Simple ileo-transverse colostomy* without division of the ileum; this procedure is only mentioned to be condemned; temporary relief may be obtained but the disease never really subsides and eventually the inflammation may spread up into the transverse colon via the anastomosis.

Ileo-transverse colostomy with division of the ileum proximal to the disease. In this operation the inflamed ileum is completely rested with a minimal disturbance to the patient. In the event of the excluded loop giving trouble it may be excised later. I think this is probably the best routine procedure to adopt and, according to Crohn, is the one which carries the least risk of recurrence. It should not be practised in the presence of a fistula as the patient may suffer from a permanent mucous discharge from the excluded loop.

(3) *Complete excision of the inflamed bowel* with ileo-transverse anastomosis. This may be a difficult procedure owing to adherent loops of gut and friable œdematous mesentery. The immediate mortality figures are, however, about the same as after a simple exclusion operation.

Patients with recurrent symptoms after radical surgery are a great problem; the higher up the lesion and the greater the amount of bowel involved the more cautious should the surgeon be about further resections. Removal of too much bowel may lead to malnutrition and further recurrences in these unfortunate patients are all too common. As a rule obstruction is the only absolute indication to further surgery.

Results of Surgery

Immediate.—The immediate results of the past 31 chronic cases operated on at the London Hospital have been as follows: Excision has been carried out 22 times with 1 death. There have been 4 exclusion operations with 1 fatality. Ileo-transverse colostomy has been done three times with 1 death and laparotomy twice when 1 patient died. The fatal cases were all in an advanced state of the disease except one elderly man of 72 who died of post-operative lung infection. The other fatalities occurred before the introduction of modern antibiotics.

Follow-up Records

I have not been able to trace any follow-up record before 1943; this is probably due to the war. Table I gives the results in 15 cases but the numbers are of course too small to be of any value.

Table I.—Results Following Operations for Crohn's Disease

Case No.	Year	Operation	Condition in 1952
1	1943	Extensive excision	Died. Malnutrition
2	1945	Excision	Further symptoms
3	1947	Exclusion	Well
4	1948	Excision	Well
5	1948	Excision	Well
6	1948	Excision	Well
7	1949	Excision	Well
8	1949	Laparotomy	Well
9	1949	3 Excisions	Well
10	1950	Excision	Well
11	1950	I.T.C.	Symptoms
12	1950	Excision	Well
13	1951	Excision	Well
14	1951	Excision	Well
15	1952	I.T.C.	Diarrhœa

The following 2 cases illustrate the response which may be expected from surgery.

Case I.—A woman aged 22.

Eighteen months' abdominal pain, pyrexia and loss of weight. Radiologically Crohn's disease.

10.12.47: Excision of the infected ileum with the usual anastomosis. Pathological report: Crohn's disease.

This patient did well and has been seen at intervals since that date in the follow-up department. A recent X-ray shows no recurrence.

Case II.—Man, aged 38.

Seven years' intermittent diarrhœa, worse for six months.

Radiologically indefinite.

11.8.48: Laparotomy showed extensive involvement of nearly the whole of the ileum which was bound down into the pelvis. Resection would have been difficult. The proximal ileum was divided well above the disease and the distal jejunum was anastomosed into the transverse colon.

All the patient's symptoms vanished; his weight returned to normal and he has been perfectly well ever since.

In conclusion I would say that it would be wrong to lay down the correct operation which should be carried out in every case of Crohn's disease. I feel that the wisest treatment for acute ileitis is conservative save for an appendicectomy but when chronic cases come to operation each must be judged on its merits.

If resection can be carried out safely and quickly it should be done but an exclusion operation is very often safer and in my small experience is equally satisfactory in the long run.

Right-sided Colitis

This group of infections was first described by Crohn, Garlock and Yarnis in 1947. In their experience it occurred in about 8% of colonic infections. This disease is characterized by rather severe constitutional symptoms with intermittent diarrhœa, pus in the stools and the early appearance of arthritis. Bleeding from the bowel is unusual, which helps to distinguish this infection from idiopathic ulcerative colitis.

The diagnosis is established by a barium enema which shows involvement of the right side of the colon, the pelvic colon appears normal and sigmoidoscopy reveals uninfected rectal mucosa.

If untreated the inflammation may gradually spread distally until the whole colon is involved.

In some of these patients the ileum is also diseased and it is then difficult, indeed impossible, to distinguish between a regional ileitis with extensive colonic involvement or a colitis which has secondarily invaded the ileum. It is possible that both conditions are manifestations of the same pathological process but at operation they may in part be distinguished by the presence or absence of the enlarged œdematous lymph nodes which are so characteristic of Crohn's disease.

The treatment of these infections is usually surgical; prolonged delay is unwise as the infection may in some cases proceed distally at an alarming rate. Operative treatment consists in completely isolating the infected bowel and draining it by a terminal mucous fistula; the proximal ileum is anastomosed to the pelvic colon. The infected colon may be removed at a second operation if this step is considered advisable. Division of the colon distal to the disease is necessary otherwise the infection might creep down the colon to invade not only the rectum but also the site of the anastomosis.

If the patient's general condition is good both steps of the operation may be completed in one stage but usually it is better to perform the operation in two stages.

This group of infections should never be treated by an ileostomy and to do so would be, in my opinion, a surgical disaster for the patient.

I would like to quote the following 4 cases to illustrate the treatment of this very important group.

Case III.—Woman aged 35.

History.—Eleven months' diarrhœa, intermittent pyrexia and loss of weight.

On examination.—A wasted, ill woman with an irregular pyrexia; there were no abnormal physical signs. A barium enema showed signs of inflammation of the proximal colon as far as the beginning of the pelvic colon. Sigmoidoscopy was normal to 20 cm.

In spite of general treatment and blood transfusions her condition became steadily worse.

Operation (20.8.47).—Laparotomy. Chronic inflammation of the whole of the large bowel from the cæcum to the commencement of the pelvic colon; there the disease stopped abruptly. The transition from the thick infected bowel to normal pelvic colon was most striking. The ileum was normal. Lymphatic nodes were not enlarged. The pelvic colon was divided 5 cm. distal to the disease and the proximal end brought out as a mucous fistula. The distal end was embedded. The ileum was divided, the distal end embedded and the proximal end anastomosed end-to-side into the pelvic colon. The patient made a smooth and rapid recovery and her temperature at once fell to normal.

Fig. 1 (*Case IV*).—Showing colitis affecting the large bowel from the cæcum to beyond the splenic flexure.

Since her operation she has been seen regularly in the follow-up department. Except for a slight mucous discharge from her fistula she has been well. A colectomy has not been performed.

Case IV.—Woman aged 32.

Two months' history of pyrexia, abdominal pain and diarrhœa. Was admitted with a provisional diagnosis of ulcerative colitis. A barium enema showed obvious colitis extending from the cæcum to the end of the descending colon. Sigmoidoscopy was normal to 20 cm. (Fig. 1).

25.4.51: Laparotomy. Terminal ileum and all the large bowel to the pelvic colon was involved in obvious infection. There was no definite line of demarcation between infected and non-infected bowel. The lymphatic nodes were enlarged. The infected bowel was excluded and the usual anastomosis carried out between the proximal ileum and the pelvic colon. She made a good recovery.

30.12.51: Readmitted because of offensive discharge from the mucous fistula and several attacks of pyrexia.

9.1.52: Subtotal colectomy and removal of terminal ileum carried out. The patient did well and has so far remained perfectly fit.

Pathological report.—Ileitis and colitis; probably Crohn's disease. Ulceration of mucosa and submucosa showing small ulcers in terminal ileum, confluent in cæcum and ascending colon, discrete in descending colon, lymph nodes showed chronic inflammation.

FIG. 2 (*Case V*).—Right-sided colitis with infection as far as the splenic flexure.

Case V.—Woman aged 22.

History.—One and a half years' abdominal pain with intermittent diarrhœa. She had lost over 2 st. in weight.

On admission.—Wasted young woman with a palpable tender cæcum and transverse colon. Sigmoidoscopy was normal and a barium enema showed infection of the right colon as far as the splenic flexure. A follow-through meal demonstrated disease in the terminal ileum (Fig. 2). Despite medical treatment she got weaker.

2.5.52: A course of ACTH was commenced. 25 mg. six-hourly for seventeen days then 20 mg. six-hourly for five days and then gradually in diminishing doses until the drug was stopped on 6.6.52. There was an immediate clinical improvement; her diarrhœa grew less, her weight rose rapidly to over 9 st. and her general outlook on life improved. Directly the ACTH was stopped a relapse set in and an X-ray showed no improvement of the disease.

8.10.52: Laparotomy. The terminal ileum to half-way down the descending colon was involved in chronic inflammation. There were many enlarged lymphatic nodes. An exclusion operation was performed between the ileum and the pelvic colon. She did well and was later readmitted for a colectomy which was successful. The pathological report was regional colitis chiefly affecting the right side of the colon and slight infection of the last 3 in. of the ileum. The microscopical appearances were those of Crohn's disease.

Case VI.—Man aged 18.

History.—Eighteen months ago, onset of diarrhœa with pus and a little blood in the stools. Ten months ago worse and admitted to the London Hospital.

On examination.—Ill young man with an irregular pyrexia, there was a palpable mass in the right iliac fossa. An X-ray showed an ulcerating lesion of the terminal ileum, ascending and part of the transverse colon.

16.1.50: Laparotomy (Mr. Hermon Taylor). Right hemicolectomy performed with removal of half the transverse colon. Ileo-transverse colostomy carried out. The patient did well.

Pathological report.—Chronic colitis, no ulceration of the ileum, no evidence of tuberculosis.

Comment.—These 4 patients (Cases III–VI) all presented with symptoms and signs of right-sided colitis; 3 were treated by exclusion operations and 1 by immediate excision. The last 3 cases clinically and at operation resembled extensive colitis similar to that described by Crohn in the ileum; the first case appeared to be of a different nature but as we have never removed the colon the exact pathology is not yet known. The immediate clinical improvement noted in the third patient after the administration of ACTH is interesting, as it is similar to that experienced with the use of the same drug in the treatment of ulcerative colitis. While the ACTH is being given the response is usually good but relapses frequently occur especially in the chronic cases.

SEGMENTAL COLITIS

These infections differ in my view from the previous groups since the lesions are strictly local and usually have normal bowel on either side. They may affect separate segments of the large gut at the same or different times and the diagnosis from carcinoma or diverticulitis is sometimes difficult. The symptomatology includes diarrhœa, wasting, anæmia, an abdominal mass and intestinal obstruction. A barium enema is usually but not always diagnostic. This group is in my experience rare; the treatment is generally surgical either because the diagnosis may be uncertain or because of obstructive symptoms. Resolution may occasionally occur, as it does in the other groups we have been discussing. The surgical treatment consists of excision with anastomosis of the large bowel.

The following case records illustrate some of the above points:

Case VII.—Woman aged 41.

History.—Admitted to hospital with several months' abdominal pain, wasting and anæmia. An X-ray was suggestive of a carcinoma of the stomach.

19.11.43: Laparotomy. The transverse colon was converted into a narrow indurated tube with injected blood vessels. The remainder of the colon appeared normal. This was the first case of the disease I had met with and I did nothing but close the abdomen. She was put on a low residue high vitamin diet. Her pyrexia gradually subsided, and the mass in her abdomen disappeared.

18.1.44: A barium enema showed a little spasm of the transverse colon.

She was sent home in March 1944 but unfortunately was lost trace of. This seems to be a case which did subside spontaneously after laparotomy.

Case VIII.—Man aged 72.

History.—Seventeen months' increasing lassitude and anæmia with diarrhœa and black motions.

On examination.—Anæmic old man; no abnormal physical signs. A barium enema showed a tubular transverse colon.

10.1.52: Laparotomy (Mr. Hermon Taylor). Localized infection of the transverse colon found; the remainder of the bowel was normal. Resection carried out. The patient has remained well to date.

Pathological report.—Generalized inflammatory-celled infiltration of all coats of the colon; ulcerative lesions of the mucosa are present.

Case IX.—Woman aged 48.

1944: Excision of the pelvic colon for supposed carcinoma elsewhere. Had remained well since then.

August 1952: For past month had attacks of colicky right-sided abdominal pain and was admitted as a ? right renal colic. Renal investigations were negative.

On examination.—Tender lump in the right iliac fossa. A barium enema showed a filling defect in the cæcum.

10.9.52: Laparotomy. Hard lump felt in cæcum; considered to be another primary neoplasm. Right hemicolectomy performed with vent through blind end of transverse colon. Did well save for temporary fæcal fistula.

Pathological report.—Chronic granulomatous inflammation of all coats of the cæcum. The ascending colon and ileum were normal. The findings suggest a localized pyogenic and granulomatous inflammation of the cæcum allied to Crohn's disease.

Following this report we wrote a letter to the hospital where the first operation had been performed; they kindly looked up their pathological report and told us that there was no carcinoma but an area of chronic colitis in the pelvic colon.

Here we have an example of a patient developing two separate lesions of segmental colitis in different parts of the colon at widely separated intervals. Both times the clinical diagnosis was that of carcinoma.

Granulomatous Tuberculosis

These infections are nowadays uncommon in a general hospital; this is in part due to a decrease in the incidence of the disease and in part to a more accurate pathological diagnosis since before 1936 a great number of cases of so-called ileo-cæcal tuberculosis were probably Crohn's disease.

From 1921–36 76 patients were treated at the London Hospital with a diagnosis of tuberculosis of the ileum or cæcum. From 1937–52 only 12 cases have been proved at operation and during the same time 40 patients have been operated on for Crohn's disease.

At the present time the diagnosis is usually made by X-ray examinations together with the presence of tubercle bacilli in the stools.

Surgical treatment is, as a rule, only called for in the presence of intestinal obstruction. In these cases a simple anastomosis to by-pass the obstruction is often all that is required. Tuberculous lesions in the small gut produce circular ulcers which may obstruct but do not tend to spread up or down the bowel so that exclusion or resection procedures are not often performed.

Modern chemotherapy, of course, plays a very important part in the pre- and post-operative treatment.

Case X.—Woman aged 50.

Six years' intermittent abdominal pain. Investigations essentially negative.

18.6.47: Laparotomy. A loop of ileum about 2 ft. long was found to be the site of multiple circular ulcers. The diseased bowel was excised. The patient did well and has remained well since. The pathological report was tuberculosis of the small intestine.

Case XI.—Woman aged 60.

Two months' abdominal pain and vomiting. No definite signs.

12.5.48: Laparotomy. Tuberculous ulcers of the ileum producing some obstruction. An ileo-transverse colostomy was performed. The patient did well and has remained free from symptoms.

Case XII.—Woman aged 31.

History.—Five years' recurrent attacks of abdominal pain and vomiting.

Twelve months ago: Operation for appendicitis, tuberculous peritonitis found. Chest X-ray showed bilateral pulmonary infection.

Two months ago: Severe abdominal pain, admitted to the London Hospital under the care of Dr. Kenneth Perry.

24.4.52: A thin wasted woman with signs of lung infection and a tender swelling in the right iliac fossa. There were tubercle bacilli in the stools and a barium enema showed spasm of the ascending colon.

30.4.52: Course of Rimifon commenced, 100 mg. daily for 100 days.

11.5.52: Developed signs of intestinal obstruction.

Laparotomy (Mr. Richardson). Extensive tuberculous peritonitis mainly involving the ileo-cæcal region. There was considerable œdema of the infected bowel. Ileo-transverse colostomy was performed.

8.6.52: Streptomycin 1 gramme daily was started in addition to the Rimifon, and the patient continued gradually to improve with gain in weight and diminishing pyrexia.

21.7.52: A barium meal showed the anastomosis was normal and that the infectious process in the colon was less. This case illustrates the value of chemotherapy in tuberculous infections of the bowel; it is interesting to speculate if it was the Rimifon which precipitated the attack of acute obstruction by producing œdema in the infected intestine. Apparently this drug may cause œdema in tuberculous lesions as a preliminary stage in the healing of the affected foci.

Actinomycosis

For many years the London Hospital appeared to be particularly fortunate in collecting cases of actinomycosis, and in 1943 I was able to study the records of 50 patients with this disease who had been admitted between the years 1936–42. 16 of these were abdominal infections and 6 of the latter group died giving a mortality of 37% which was not as high as might have been expected. Since the introduction of penicillin the incidence of this disease appears to have dropped in all parts of the body. It is probable that the routine administration of chemotherapy after operations for acute appendicitis and for the treatment of acute dental sepsis has materially reduced the numbers of cases in this country.

It was pointed out by Morton (1940) that abdominal actinomycosis may present in three ways:

Group 1: As a typical case of appendicitis, operation is performed and is followed in due course by a residual abscess with sinuses.

Group 2: These patients present with a lump in the right iliac fossa which gradually breaks down to form typical tracks.

Group 3: May start as either of the above groups but abscess formation is unusually rapid and, if undrained, the pus may track up into the liver, down into the psoas sheath or back around the kidney.

The diagnosis can only be established by the bacteriologist and a careful and repeated search is often required. Surgical treatment nowadays is generally confined to adequate drainage of any pockets of pus; formal excision is not usually practised. Penicillin should be given in doses of from 1,000,000 to 2,000,000 units a day for periods of from three to six months. This prolonged course may be supplemented by short repeated courses of streptomycin; other antibiotics such as Aureomycin and Terramycin have also been employed.

Injection of the sinuses with a solution of penicillin or streptomycin is often valuable as systemic treatment may fail to reach all parts of the infection owing to the dense fibrous tissue which is so characteristic of this disease.

Iodine therapy is no longer required and radiotherapy seems to have little effect on the abdominal variety of the disease though it is still very valuable in the treatment of thoracic infection.

The results of modern therapy are most encouraging and Florey (1952) quotes a series of 27 abdominal infections by various authors all of whom gave their patients penicillin. 89% recovered. Cases of liver infection have been successfully treated so that hope should not be given up, however advanced the infection. In long-standing cases the danger of amyloid disease should be borne in mind as it may lead to a rapid and unexpected deterioration in the patient's condition.

Conclusions

It is now possible with careful radiological and bacteriological examinations to distinguish fairly accurately the various granulomata of the small and large bowel and to differentiate the colonic ones from idiopathic ulcerative colitis.

The first three conditions we discussed have no known bacteriological cause so that the medical treatment is, of necessity, non-specific and it follows that surgery is frequently required to remove the offending portion of bowel. In time, no doubt, the ætiology of these diseases will be discovered and specific therapy largely replace the need for surgery, as has been the case with actinomycosis and tuberculosis.

During the past few years great advances have been made in the diagnosis of various types of colonic infection and it is essential that every encouragement be given for further work in this field so that the exact cause of these infections be found out and specific therapy applied.

Finally I would like to thank all the members of the Medical and Surgical Staff of the London Hospital who have so generously placed their records at my service; without their help my task would have indeed been difficult.

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Section of Anæsthetics

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Aids to Anæsthesia

PRESIDENT'S ADDRESS

By M. D. Nosworthy, M.A., M.D.

I have chosen "Aids to Anæsthesia" as my subject because in 1932 Dr. Hadfield called his Presidential Address "Modern Aids to Anæsthesia"; and I thought it might be worth while to take stock and see how the whole attitude to anæsthesia has changed during the past twenty years.

In his Address last year Dr. Gillies (1952*a*) outlined the general trend in anæsthetic development from one of pathological disturbance towards that of physiological trespass. Trespassers, however, as well as disturbers of the peace, can land themselves in Queer Street. I therefore propose to devote some time to practical points of administration and outlook.

Dr. Hadfield ranged over the whole field of general anæsthesia; but, if I am going to dip into the past, scan the present, and try, here and there, to peer into the future, my review must necessarily be incomplete and some overlap of thought must be taken for granted.

New and Old Methods

By 1932 various forms of basal hypnosis were coming into fashion, whereas its use to-day is almost confined to special cases. The uncertainty of effect when barbiturates are given by mouth was recognized twenty years ago, but the practice has persisted, as a method of premedication for children, even to this day. Dr. Anderson (1951) has made the value of omnopon-scopolamine for these patients more widely known.

The barbiturates, sodium amytal and Nembutal, were sometimes given by the intravenous route, and a single injection provided a steady level of hypnosis for an hour or more. Wild post-operative restlessness was, however, a dangerous feature of overdosage. Nowadays, after a preliminary hypodermic sedative, thiopentone—except in special cases—provides the routine and pleasant method of starting anæsthesia. To-day we recognize barbiturates essentially as hypnotics and not as analgesics, and we also now know more about their fate (Brodie *et al.*, 1952; Keele, 1952). We can, therefore, appreciate why an excessive dose of even thiopentone may—in the presence of post-operative pain—give rise to the same restless state. The correct treatment, I am sure, is prophylactic, and the modern tendency to curtail the dose of barbiturate and sometimes to supplement nitrous oxide-oxygen with intravenous injections of pethidine seems to me a wise and logical development (Mushin, 1951; Brennan, 1952).

Vinesthene and trichlorethylene are relative newcomers; the former is too expensive for most people's pocket, but the latter—often vaporized from most ingenious apparatus—seems to be finding its niche as an analgesic in midwifery, and as a possible adjuvant to nitrous oxide-oxygen. Ethylene was ousted almost before it gained a footing in this country, partly because of its unpleasant smell but also because of the arrival of that more flexible agent, cyclopropane.

Although the concentration of cyclopropane, when given with a muscle relaxant, is insignificant compared with that required heretofore, and although a momentary addition can be dispelled as quickly as it was introduced, yet many anæsthetists cling—at all times and at all costs—to nitrous oxide-oxygen, preferring to supplement a harmless but feeble combination with strong injections which, though quick and easy to give, cannot always be so readily dispersed. No doubt, I am thought just as obstinate for being against "routine" anæsthesia and against its adjustment by the clock !

Use of the diathermy needle now often limits the choice of anæsthetic drugs. A welcome addition to the existing range would be a new, quick-acting, non-explosive agent of somewhat greater potency than nitrous oxide, which could be used with CO_2-absorption and with excess oxygen. Of course, if one can persuade a surgeon to knock off for a cup of tea in the middle of a long and difficult operation, the atmosphere in the theatre often becomes much less heavily charged!

In my early days respiratory arrest from *too much* anæsthetic was so dreaded by some anæsthetists that reflex inhibition of respiration from *too little* anæsthetic was not an uncommon sequel. Time, the Great Healer, was probably a greater factor in restoring spontaneous respiration than were the perfunctory pulls on the chest, the four fingers inserted into the rectum, or the stimulants then injected with one eye on the witness-box. I personally was brought up to use deep ether, with only atropine for premedication, and, although I always aimed to produce respiratory arrest before the peritoneum was opened, breathing was *invariably* resumed without any active treatment on my part. At such a depth the risk of reflex disturbances of respiration had long since passed and seldom came back later on, even though the concentration of ether was much reduced.

Chloroform was still extensively given in 1932 and, although its use can always be avoided nowadays—except possibly for a prolapsed cord in midwifery—the alternative methods must sometimes seem cumbersome and not entirely devoid of hazard to those who know their chloroform. In the late 1920's when I was a Resident Anæsthetist, it was not appreciated how little the anæsthetic agent itself contributed to post-operative pulmonary complications. I was therefore expected to give chloroform—on an open mask with no bag to help me—for the suture of acute gastric perforations. Since all these patients were given morphine 1/4 grain as soon as the diagnosis had been made, I often found it impossible to relax the abdominal muscles and to suppress all reflex activity before the respirations faded away.

The worst difficulty I recognize—because it is a pit one has so often dug for oneself by over-premedicating the patient—is to have excessive central depression without adequate peripheral suppression; and the more I learn about collapse of lung the greater importance I attach to reflex contraction of the bronchiolar muscles.

Seldom was it possible with cyclopropane alone to obtain complete reflex suppression and full muscular relaxation, without following Dr. Guedel's example (Guedel, 1940; Nosworthy, 1941) and working, with passive ventilation, at an extreme degree of central depression.

Who has not got himself into trouble by attempting too much with thiopentone? So that I could give enough thiopentone to prevent reflex response I sometimes used to prolong the activity of the respiratory centre by injecting nikethamide at the same time. Dr. Morton (Fatti and Morton, 1944) used to tackle the problem of bronchoscopy under thiopentone rather differently; he stimulated the respiratory centre to such an extent with carbon dioxide that the patient was kept so busy breathing he had no time to go into reflex spasm.

In the past, therefore, whenever complete muscular relaxation and full reflex suppression were necessary, the recurrent problem was how best to obtain the essential peripheral quiescence without deep and prolonged central depression. Knowledge, and anticipation of the requirements of different stages of an operation helped, but the problem fundamentally remained unsolved except by regional blocks, by stunts, or possibly by nauseating concentrations of ether.

No wonder that the coming of curare, *with its peripheral depressant action*, was greeted with profound relief by anæsthetists, and with unconscious thanksgiving by patients who could now be spared excessive central depression and the general intoxication which goes with it.

In 1932 carbon dioxide was regarded as a panacea for all ills (Nosworthy, 1937), even—believe it or not—for supporting a failing circulation during operation. Few British anæsthetists were really CO_2-conscious—in the broadest sense of the term—until after Dr. Waters spoke on CO_2-absorption to this Section in 1936.

In years gone by, the ability to perform blind nasal intubation not only saved time but often spared the patient a deep narcosis. The technique was condemned by some anæsthetists, but this reaction was more often due to unfamiliarity with the method than to recognition of the greater risk of papillomata developing on the vocal cords. Now, since the advent of relaxants, and more particularly succinylcholine, the need for dexterity in the blind technique has virtually disappeared. Every now and then, however, the blind method provides the answer to an awkward situation. The possibility of insinuating a nasal tube beneath the mucous membrane of the pharyngeal wall is a fairly recent discovery; perhaps the tube of to-day is less friendly than its predecessor, or else the art is being lost.

Spinal analgesia for thoracotomies and likewise the laborious manœuvre of bronchial tamponage had mercifully only a short innings (Crafoord, 1938; Magill, 1941). Modern methods for intra-thoracic work were discussed here last year (Nosworthy, 1951; Millar, 1952); but I was interested to learn recently that in some parts of America, the face-down posture is still known as Gale's position, although Dr. Gale himself abandoned it for the lateral approach over twenty years ago!

Recent research—some, as yet unpublished—has thrown light on the effects of anæsthesia upon liver and kidney function (Waters, 1951; Miles *et al.*, 1952), but we are still largely in the dark and want to know more about changes in coronary and cerebral blood-flows.

Various Aids

Until quite recently anæsthetists had to rely upon clinical observation and their past experience for appraisal of the patient's condition. Now, besides more accurate flowmeters, there are available electrocardiographs, gas-analysis machines, oximeters, tachometers, and even encephalographic tracings for determining the depth of central depression.

Each has its place in teaching and research, and these aids can also possibly serve a useful function in day-to-day anæsthesia, so long as they are regarded as adjuncts to clinical assessment, and not as alternatives to the anæsthetist's personal contact with his patient. Many years ago an older colleague said to a friend of mine, who was taking blood-pressure readings during an operation: "If you don't know how your patient is without taking his blood pressure you are no good as an anæsthetist." It is surely wrong thus to damp enthusiasm and to condemn a healthy attitude of enquiry. I myself made a routine practice of keeping blood-pressure records and I often used to count the pulse on the manometer as the mercury fell. One day, the ward-sister, who had her fingers on the patient's pulse during a thoracotomy, turned to me and said "He's not so well". I blew up the mercury and found that blood pressure and pulse-rate were just the same as before. A few minutes later the sister remarked "He's better again". Once more I blew up the mercury and found the blood pressure and pulse-rate still unchanged. Thereafter I took to keeping my own finger on the pulse, and found that I could detect changes, presumably in the calibre of the vessel, which waxed and waned with what the surgeon was doing, and which occurred sometimes without, but always before, any change in blood pressure. Therefore, although I like a record of blood pressure as an additional aid and to make my notes more complete, I rely much more on the feel of the pulse, the feel of the patient, and the feel of the breathing-bag.

Not infrequently one reads reports of patients whose blood pressure and pulse have suddenly disappeared for no apparent reason. Judging from my own experience such an event—in a properly anæsthetized patient—must be a very rare occurrence, and I believe that closer observation of the pulse beforehand would have detected some abnormality which should have suggested danger. I wonder how many anæsthetists have rehearsed in their own minds what they would do in the event of any given emergency. Such forethought is a worth-while exercise and may well reduce the critical latent period of response. Now that cardiac surgery provides direct observation of the heart's action with a simultaneous electrocardiographic record, a clearer picture is gradually coming into focus of the mechanism of cardiac arrest, and of the place and value of such drugs as procaine and Methedrine, adrenaline and nor-adrenaline, and also of the defibrillator (McMillan *et al.*, 1952).

The comparative ease and speed with which blood can now be procured to meet the demands of a sudden emergency is very different from the state of affairs before the last war. Then it might be an hour or more before a donor even arrived; and in those days a transfusion seldom exceeded 25 ounces.

Those who have had experience of a good theatre orderly, or a trained anæsthetic technician, will rank his services among the most valuable of aids to anæsthesia. His ability to help, and to produce whatever is wanted without delay, is a great saving in wear and tear. Contrast the lot of the lone anæsthetist of to-day who often arms himself with a veritable battery of syringes ready charged to meet every possible requirement of a long operating list.

To one like myself, who has had to do mouth-to-mouth inflation on two patients with pulmonary sepsis, a fully equipped recovery-ward (Davies and Hunter, 1952) seems a development to be welcomed from every point of view, so long as it does not encourage anæsthetists to become more haphazard over drug-dosage, and so to shelve their legitimate responsibilities on to someone else.

Teaching

Receiving no systematic instruction after his student-days the resident anæsthetist of the past learnt by bitter experience at the expense of his patients. There can be no question—certainly at a teaching hospital—that the resident anæsthetist of to-day is much better taught and becomes far more expert than I ever was in my day. In fact, he soon gives such good up-to-date anæsthetics that he is often persuaded to tackle cases beyond his experience and, until he has had a good fright, he may give up calling in the anæsthetic registrar for help with serious emergency operations.

Whether practical anæsthetics—as distinct from care of the unconscious patient—should now be regarded entirely as a postgraduate study is a question for another occasion. I believe that the trainee should first learn the Boyle's machine with ether as the principal agent. A little thiopentone can provide a pleasant start, and perhaps a *small* dose of relaxant can be used if necessary. The beginner will, in my opinion, pick up the fundamentals more quickly, and more surely, with a slowly-moving vehicle like ether, just as he will—at this stage of his training—learn more from a breathing than from an apnœic patient. Every pilot of a jet-fighter first graduated on a Tiger Moth. I sometimes wonder whether experts do not forget their own early difficulties; a condition which they now instantly, and almost automatically, diagnose may not be at all obvious to the beginner.

Some anæsthetists state that the signs of anæsthesia as set out by Dr. Guedel (1937) and amplified by Dr. Gillespie (1943) are not applicable to modern methods. When I wish to demonstrate them, I personally find no difficulty in their application so long as it is appreciated that, compared with

ether, cyclopropane is a far greater central than peripheral depressant, and that thiopentone is even more so. The apparent difficulty lies, I think, in the fact that with cyclopropane it is so easy to run through several degrees of central depression in one fell swoop. The same applies, on the peripheral side, to the relaxant drugs; unless they are given in small, or divided, doses the terminus of complete reflex suppression and full muscular relaxation is reached—and often, in fact, overshot—without a stop at any intermediate station. The signs are there, however, for those who are not in too much of a hurry to see them. Fresh signs (Morton, 1945, 1950; Durrans, 1952), such as the feel of the bag and the force of expiration, have been added to the old; the suggestion has even been made that the complication of hiccup should be pressed into service as a sign, just as the tracheal tug was many years ago.

Dr. Crampton (1934) emphasized the importance of an anæsthetist being able to handle patients. "Personality", he said, "is non-toxic and does not throw any strain on the heart, liver or kidneys, nor does it depress respiration." In spite of the truth of this statement, the accommodation provided for the anæsthesia of children in many Out-patient Departments is in urgent need of expansion. The institution of Anæsthetic Out-patient Clinics (Lee, 1949; Green and Howat, 1952) is a recent innovation which shows that space for development can be found.

The Modern Scene

I think we can be justifiably proud of the contributions of British anæsthetists to our specialty, and of the prestige of British anæsthesia to-day. Watching, as I do now, somewhat from the side-lines there are, however, certain observations which I should like to make about the modern scene.

It is natural, I suppose, for older anæsthetists—without being obstructive—to reserve judgment on new developments, and perhaps even to regard with a certain amount of disquiet techniques which involve four or five quite different intravenous injections apart altogether from hypnotic or analgesic drugs.

The view that agents and methods in current use are less harmful than their predecessors is no new conception. Each new drug has been heralded by its advocates as approaching more closely to the ideal. Later, stress came to be laid on the importance of the anæsthetist, the actual agent being deemed, by some, as immaterial. The coming of curare probably marked the most important advance since the discovery of ether anæsthesia, and its dramatic properties swung the pendulum of moment back once more towards the importance of drugs. Nearly all patients now come to operation in good heart, largely due, I believe, to their having noticed how little others in the ward were upset by their operations; and this attitude of mind is, I think, a striking testimony to the direct benefit of curarizing agents.

New relaxant drugs are produced with such rapidity, however, that it is wellnigh impossible for any one man to assess each new arrival properly. Is it too much to ask that the manufacturers should submit their products to a more extensive clinical assessment before making them generally available?

Hypotensive techniques have been thought only indirectly to benefit the patient by curtailing his blood loss and by increasing surgical visibility. The actual techniques have been described here on more than one occasion (Enderby, 1951; Davison, 1951; Gillies, 1952*a*, 1952*b*), and at the meeting of the Section of Surgery in February the end-results of the method are to be discussed and fresh claims, I understand, put forward for it. I will, therefore, content myself with just two comments: first, for an anæsthetist to be in a hurry is a bad start to any anæsthetic, but to rush a hypotensive technique is just asking for trouble; and secondly, surgeons now appreciate the value of posture, and are prepared to operate with the patient in positions which they would never have tolerated before the introduction of this technique.

Patients still die from anæsthesia, however, and the members of the "Deaths" Committee of the Association of Anæsthetists have spent a great amount of time and energy in analysing reported deaths. It is regrettable that some anæsthetists have not bothered to acquaint the Committee with details of their fatalities. So far two striking findings have emerged (Morton and Wylie, 1951, 1952): firstly, the high proportion of reported deaths which are due to aspiration of vomitus; and secondly, the significant number of patients whose death has been attributed to a thiopentone-induction.

Although the modern dictum "my technique is non-toxic" need not be far from the truth, the drugs of to-day and the side-effects of physiological trespass (Gillies, 1952*a*) can—in the hands of the tyro—be just as lethal as the techniques of yester-year. It has, in fact, always been true that patients can only benefit to the full from advances in drugs and techniques when these are linked with similar advances in the training and pharmacological knowledge of those who use them; and the pendulum of moment must come to rest equidistant between man and mount.

It has been suggested that, since the structure of anæsthesia consists of the triad Narcosis, Analgesia and Relaxation, a properly balanced piece of work will rest most safely and securely upon the tripod of Thiopentone, Nitrous Oxide and Muscle Relaxant.

I personally mistrust attempts to reduce the art of anæsthesia to an exact science; and I rather fear that this triad—now perched on its base of Apnœa (Gray and Rees, 1952)—may get the unsophisticated into trouble by restricting their horizon to, so-called, "specific" drugs. In parenthesis, how would you anæsthetize, for hilar denervation, a patient who goes into status asthmaticus as soon as he is spoken to?

I would prefer a young anæsthetist to approach each patient, and every operation, with an open mind, and to design his work of art only after reckoning how much peripheral suppression will be wanted and only after sizing up the position as a whole. He will often, no doubt, base his design upon thiopentone, nitrous oxide and a muscle relaxant, but he need not inevitably jettison every other drug; nor need he feel guilty if he changes his plan to meet unexpected stresses and strains.

There appears to be a tendency nowadays to shun simplicity; the elaborateness of the selected technique often seeming to offer no commensurate value to the recipient. Recently a colleague of mine watched a perfectly ordinary patient, with an internal derangement of the knee-joint, intubated under thiopentone and Tubarine, ventilated with nitrous oxide-oxygen for the twenty minutes required to complete the operation, and then—if I may coin the word—antidoted with neostigmine and atropine.

It is, I believe, a wise precaution to master the more complicated techniques on simple cases before applying them to more difficult operations; but this is not always the explanation for such a choice. Again, I am strongly in favour of subduing, at the start, the reflexes involved by any operation, and thus surmounting the crux of most anæsthetic problems (Nosworthy, 1948); but surely it is rather crude to transport a patient all the way to Land's End when he only needs to go just a little way down the Great West Road! Sometimes, of course, anæsthetists are not prepared to give their undivided attention to the job on hand; perhaps this was so in the case I have just cited.

Some anæsthetists pass an endotracheal tube on every patient to save themselves the trouble of holding up the chin; I do not say that routine intubation is necessarily wrong—such an attitude just seems to me pathetic. Even when respiration is controlled, tracheal intubation need not be a *sine qua non*.

The average anæsthetist of to-day thinks nothing of apnœa; when an induction-apnœa persists longer than expected, however, there is a tendency to blame the latest discovery or the last drug given, instead of regarding the whole phenomenon as a summation of central and peripheral effects.

Then, again, there is the patient who, although quite fit so long as artificial ventilation is continued, will not breathe on his own, or only does so inefficiently, at the end of operation. Before the days of relaxant drugs, an anæsthetist who practised the apnœic technique had to rely upon his own ability to restore the function of respiration to the patient by the time the operation finished. With this end in view, during the closing stages he eliminated the inhalational agent—which was usually a more potent one than nitrous oxide—and he also allowed carbon dioxide to bank up for a moment or two in case he had over-ventilated his patient.

Now, with an antidote supposedly up his sleeve, the anæsthetist of to-day is often more liberal than he need be with his doses of relaxants—and with other injections, too, for that matter—and he does not always seem to realize how small a "topping-up dose" can often be. Further, when apnœa has been produced at the start by thiopentone and a muscle-relaxant, and then just nitrous oxide with more relaxant given during the operation, it is not always appreciated how long-lasting the original central-depressant element may sometimes be; the injection of nikethamide (Doughty and Wylie, 1951) may produce a dramatic response when it is thought that the continued apnœa must be entirely due to peripheral paralysis.

I am not really the right person to talk about the intelligent use of neostigmine (Doughty and Wylie, 1951, 1952; Nosworthy, 1950); but what is a simple soul to make of such diverse and contradictory advice as this? *After a curarizing agent*, one man recommends the giving of neostigmine even if the patient is still apnœic; another, only when there is at least some spontaneous activity. One man advises the injection of nikethamide first, and neostigmine not till later—and then only if absolutely necessary; another injects neostigmine even when there is no clinical evidence of residual curarization. One man gives neostigmine as a routine procedure after using cyclopropane with a curarizing agent; another regards this practice as fraught with danger. *After a depolarizing agent* one anæsthetist is surprised when an apnœic patient makes no respiratory response to neostigmine; another maintains that neostigmine *is* an antidote to depolarizing drugs!

This is a fantastic state of affairs. Apart from the production and maintenance of apnœa being at times unthinking, failure to distinguish between central and peripheral respiratory depression, and ignorance of pharmacological effects are bound to reduce final treatment to one of repeated hit or miss. It is high time, therefore, that the advocates of resuscitants give explicit guidance and somehow instil into the rank and file full appreciation of the causes and management of depressed states.

Throughout this review I have tried to indicate why patients—when handled by fully competent anæsthetists—should benefit from our increased knowledge and from many, if not all, the recent developments. Whether the intricacies of some techniques represent a true advance, time alone will show.

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Dr. A. R. Hunter (Manchester): There are two ways in which paralysis due to the action of myoneural blocking agents can be reversed. Thus the concentration of the acetylcholine at the end-plate can be increased to such abnormally high levels that the barrier due to the curarizing drug is broken down, as it were, by sheer force of numbers. This occurs when anticholinesterases, like physostigmine, are given. Reversal of paralysis can be obtained by this means only with substitution blockers like *d*-tubocurarine. The restoration of function is more or less permanent and occurs at almost any depth of curarization.

The second way in which paralysis due to myoneural blocking drugs can be reversed is by increasing the sensitivity of the muscle end-plates to acetylcholine. The power of doing this is possessed in some degree by almost all drugs with a terminal trimethyl ammonium, or similar, group. It is most marked in Tensilon (3-hydroxyphenyl dimethylethyl ammonium bromide) but even decamethonium in suitable doses can produce the same effect. The reversal of paralysis produced by agents of this type is non-specific, being obtained with both substitution and depolarizing blockers. Indeed, increased sensitivity of the end-plates to acetylcholine with increased muscular activity can be produced by such drugs in the uncurarized patient. Unfortunately these agents will reverse only relatively slight degrees of myoneural block, and even then their action is usually only temporary.

Neostigmine is an antidote with a dual action. By virtue of the carbamate portion of its structure it is an anticholinesterase. It also possesses a trimethyl ammonium group and because of this it also has, to some extent, the power of making motor end-plates more sensitive to acetylcholine. Therefore, in addition to being an effective antidote to the substitution myoneural blocking agents, it possesses the ability to reverse, to some extent, muscle paralysis especially of the partial variety which is due to the depolarizing myoneural blocking agents. This action, however, is weak and evanescent and not one upon which any great reliance may be placed in clinical anæsthesia.

None the less, the effect can occasionally be sufficiently obvious, especially in lightly "curarized" patients, to make it appear that neostigmine is a satisfactory antidote to depolarizing as well as to substitution myoneural blockers.

Section of Obstetrics and Gynæcology

President—A. C. PALMER, O.B.E., F.R.C.S., F.R.C.O.G.

[*October* 24, 1952]

Changing Practice in Obstetrics and Gynæcology

PRESIDENT'S ADDRESS

By A. C. PALMER, O.B.E., F.R.C.S., F.R.C.O.G.

INTRODUCTION

IN thinking about this Address, it occurred to me that it might be of interest to describe some of the changes which have taken place in obstetrics and gynæcology since the beginning of this century. The idea seemed incomplete without some reference to the sudden leap forward which occurred about 1880, and a short account of this period has been included.

In a recent Address to the Osler Club, Mr. Zachary Cope told us that in 800 B.C., medicine men in China were known as physicians, dieticians and surgeons. The mention of dieticians is interesting and the omission of any reference to midwives, striking. It may be that the midwife was so low in the social scale as to be unworthy of notice, but I suspect something else. I suspect that the wise men of the day, being to some extent aware of the mystery and difficulty inherent in midwifery, turned away from it as being something too dangerous for reputation. Sir Richard Croft found it so in the case of Princess Charlotte and I venture to say that even now there are patches of mystery and difficulty in midwifery, which hold a great threat to reputation.

BREECH PRESENTATION

When a breech presentation was recognized, a casual attempt was made to turn it. If the attempt failed nothing more was done, and often enough it corrected itself. Those that did not turn spontaneously went into labour and were often safely delivered.

The cervix was examined at the start of labour and when the membranes ruptured. If the cord prolapsed, it was replaced with varying success by one of the methods then in use.

We were beginning to learn something about bringing down legs when the breech was held up in the pelvis. We learned to wait until the cervix was big enough to let the hand through, or until it ceased to stretch, beyond allowing manipulation by two or three fingers. We also learned that it was dangerous to bring down a leg with the breech still in the pelvis, and it became the rule to dislodge the breech before withdrawing a leg. If it was possible to complete delivery at once, this was done, the arms being withdrawn by the accepted method and the head delivered by jaw and shoulder traction.

About this time, Sir Eardley Holland demonstrated tentorial tears in the after-coming head, and it became necessary to pay more attention to the breech during late pregnancy. Gradually it became recognized that the rules for delivering a breech were very much the same as for delivering the head.

Professor Leyland Robinson reduced these rules into a neat little phrase of three words: "Yes. No. Perhaps." "Yes", when either end is nicely in the cavity, preferably sitting on the levator ani. "No", when the presenting end is above the brim and cannot be persuaded to enter the brim. "Perhaps", when the lower end is in the brim and can be persuaded to pass through into the cavity, but refusing to stay there rises up again as soon as pressure is removed. It is in "Perhaps" that one meets with most surprises. The fœtus may tumble out with unexpected ease or become jammed in the cavity and cause a change of tactics. The change does not matter much provided the patient is not allowed to become unduly fatigued. My inclination is to avoid fatigue altogether by making a decision before labour begins.

TURNING

Sir Eardley Holland pointed out that persistent effort to turn an unwilling breech sometimes brought about separation of the placenta and free hæmorrhage; while Dr. John Prescott Hedley said that even without hæmorrhage, such attempts might be followed by the death of the fœtus. More recently, Messrs. Peel and Clayton have reported a series of 200 versions with very little ill-effect to mother or child.

My own views about turning are still fluid. If the fœtus turns easily, I turn it and am not surprised if it is again a breech in a few days. If the breech is well engaged no attempt to turn is made, and unless the child or the head gives the impression of being unduly large, nothing further is done.

With the increasing use of X-ray, it was found that extension of the legs was common in primiparæ; in fact so common that extension was for a while looked upon as proof of a first pregnancy.

In the course of time it was again noticed that the delivery of these cases was associated with an unexpected number of stillbirths, even in the absence of tentorial tear, and it became the practice to perform Cæsarean section for all breeches with extended legs in primiparæ. This practice continued only until it was recognized that the labour should not be interfered with until the breech appeared in the vulva. An episiotomy then allowed the breech to come through and made the delivery of the legs easy. Mr. Burns of Liverpool contributed to safe delivery by allowing the fœtal body to hang from the vulva for a few minutes. This brought the nape of the neck under the pubic angle and delivery was easily completed by the Prague method.

Rigid Cervix

I have never fully understood what was meant by this term. Did it mean that the cervix was, in fact, rigid and firm; or did it mean that in spite of strong pains in the absence of mechanical obstruction, the cervix failed to dilate? I have often seen the latter but have not recognized a firm hard cervix. On the contrary, it has either been hanging loosely below the presenting part during a pain, or applied to the presenting part, its edge being thin and sharp, but again softening between pains.

Before the first war, De Ribes' bag was often used with success to dilate this type of cervix, but it was wise to complete delivery by forceps as soon as the bag was expelled, for the cervix had a habit of closing down again after expulsion of the bag. De Ribes' bag has passed away, and I doubt if it would be possible to obtain one in good condition to-day.

The late Dr. Joseph Willett, an obstetrician by choice and a head surgeon by force of war, became familiar with the skin clamps which we then used to control the bleeding from the large flaps of scalp laid back in head operations. From placing forceps on scalp flaps, it was but a short step to attaching them to the fœtal scalp, so Dr. Willett modified the hæmostatic forceps and produced Willett's forceps. It was his intention that they should be used for overcoming the rigid cervix. When the cervix was slow in dilating in spite of fair pains, Dr. Willett applied his forceps to the fœtal scalp. By means of tape, a weight (1 to 2 lb.) was attached to the forceps and hung over the end of the bed. Dr. Willett reported some good results with the forceps but their use was not widely adopted. As time passed they began to be used for partial placenta prævia and made a favourable impression until Professor F. J. Browne suggested that their use caused one of his cases to die of puerperal sepsis. After this the forceps fell into neglect and little has been heard of them since, but they can be seen among the unused equipment of the labour ward.

Central Placenta Prævia

For central placenta prævia, the use of De Ribes' bag was still accepted as good practice. I was instructed to leave the blades protruding an inch beyond the bag, so that they could be more easily pushed through the placenta which covered the os. At best this manœuvre was not easy, but cutting through the placenta with long scissors removed some of the difficulty—and added to the bleeding. Once the bag was in position, bleeding was controlled and in due course a dead fœtus was delivered from a nearly bloodless mother, whose condition was made still worse by post-partum bleeding. At this time blood transfusion was in its infancy, and not available for emergency use.

Cæsarean section now began timidly to edge its way in as treatment for central placenta prævia. It was frowned upon as a revolutionary step by men of long experience and unshakable conviction, and I well remember a revered senior asserting with great emotion that Cæsarean section had no place in the treatment of placenta prævia. About twenty years later, Professor Munro Kerr stated that Cæsarean section was the treatment of choice in all, except the slightest, cases of placenta prævia.

Cæsarean Section

I first saw this dramatic operation in 1908. A notice was displayed in the Main Hall that a Cæsarean section would be performed at 2 p.m. All those free to attend were invited, and the Theatre was packed with Housemen, Sisters, Nurses, and Students of all grades. One could see nothing until the great moment arrived, when the yelling child was held aloft after being speedily ripped from its mother's belly. A murmur of relief ran round the crowded Theatre. Since that time, I have on occasions, wished that a Cæsarean baby would yell as this one did.

At this period, silk was used to suture the uterus, and the discharging abdominal sinus began to make its appearance. Sooner or later silk sutures would be discharged, but the sinus refused to heal until the uterus was removed.

Silkworm gut sutures replaced silk and all seemed well until an occasional suture made its way into the bladder, or in some strange way turned round and the knots protruded into the uterine cavity, to be accompanied by excessive bleeding and subsequent hysterectomy. Chromic catgut sutures then superseded silkworm gut, and finally No. 2 Kalmerid forty-day gut appeared to stabilize the position, as soon as the method of stitching was changed from interrupted circular sutures to transverse mattress sutures, the uterine peritoneum being closed by continuous catgut.

During all this time, the incision in the uterus was creeping lower, while the para-umbilical incision became mid-line lower abdominal, with its highest point an inch or more below the umbilicus. Then quite suddenly the lower vertical incision became transverse in the lower segment and the operation technique appeared to be permanently established. So far as I know this position has been maintained apart from a rare exception here and there, among a few surgeons who adhere to the lower vertical incision.

Abnormal Behaviour of the Uterus During Labour

Dr. Willett was well aware of this and invented his forceps to overcome the condition, but he did not appear to recognize contraction ring which was observed by Russell Andrews, Drummond Maxwell, Clifford White and others, and later described by Sir William Gilliatt in his classical monograph on the subject.

Sir William told us that the ring need not be confined to the lower segment. It might occur at any level of the uterus, as suggested by Andrews.

I have recently had the opportunity of seeing such a ring in the middle of the upper segment, a little above the level of the umbilicus. It could be seen as a bilateral indentation when looking at the patient from the front, and as a depression near the umbilicus when looking at the patient from the side. A young woman of 25, having her first baby, had been in labour for forty-six hours. She had run the usual course: Primary inertia, secondary inertia, followed by twenty-two hours of uterine colic, unrelieved by sedatives. When I saw her she was exhausted, grey in colour and difficult to control. The uterus failed to completely relax between pains, and the ring was still seen as described. The cervix was nearly half dilated and hanging down below the head at the height of contraction. It appeared that Cæsarean section offered the only solution and the ring could still be seen when the abdomen was opened. After removal of the child, when the uterus was firmly contracted and retracted, a sulcus about an inch in width was found joining the uterine ends of the round ligaments. The muscle in the sulcus was less than half the thickness of that above and below. The placental site was on the posterior wall of the upper segment, and no abnormality was felt in this region (Figs. 1 and 2).

In my experience, this case is unique.

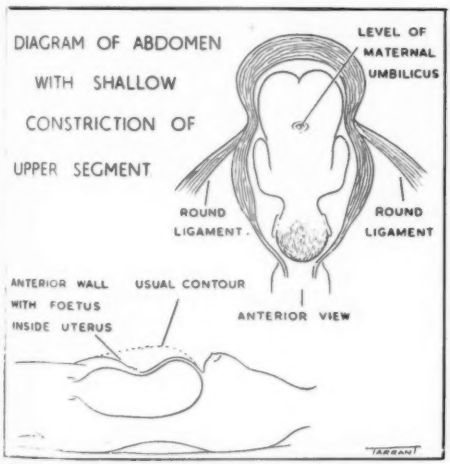

Fig. 1.—Diagram of abdomen with shallow constriction of upper segment.

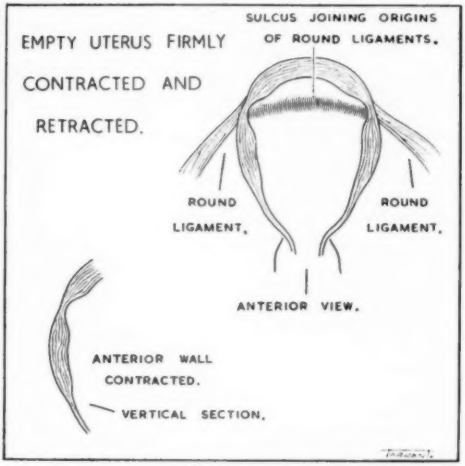

Fig. 2.—Empty uterus firmly contracted and retracted.

Gynæcology

A young man coming into gynæcology, now well established as a surgical entity, would find it difficult to believe that its recognition is comparatively recent. In some Teaching Hospitals gynæcology was a separate department in the early part of this century, but those who practised it still bore the title of physician. These physicians practised in Midwifery and Diseases of Women; which have since become Obstetrics and Gynæcology. In a few instances their operating was restricted to the vaginal approach, while the general surgeon retained such work as required an abdominal incision.

Turning a little further back to the latter part of the nineteenth century, it appears that in England there was a sudden leap forward in abdominal surgery during the few years on either side of 1880. This great advance is associated with the name of Lawson Tait, a man of penetrating intellect, of tremendous driving energy, insatiable curiosity and mule-like obstinacy. The time was one of intense

competition, self-advertisement and criticism of others, and Tait was a champion in all these activities. He never failed to seize an opportunity of self-glorification or of damning the work of others. He launched a full-scale attach on Listerism, and declared that his own methods of simple cleanliness gave better results, because, unlike antiseptics, cleanliness did not destroy the tissues. The battle was long and fierce, till it was eventually fought and won by the fusion of both methods into super-cleanliness or aseptic surgery. Tait had failed or refused to recognize that Listerism was only another way of trying to be clean.

The gossip of the time had it that Lawson Tait was the natural son of Sir James Y. Simpson. When this was mentioned to Tait, he smiled comfortably and remarked on the likeness between Sir James and himself. To ride happily over the taint of bastardy was merely another arrow to his bow.

Howard Kelly described Tait as: "That great pioneer in our art", and William Mayo spoke of him as: "The father of abdominal surgery."

It would appear that Tait's reputation was greatly increased when he began to use boiled thread for tying the ovarian pedicle and then returning the tied stump into the abdomen.

The delay in using a thread ligature in the abdomen is not easy to understand, for it is recorded that string was used to tie the umbilical cord in 800 B.C. (Susruta).

In England the ligature was introduced by Wiseman (1566–1625), and was eagerly adopted after Harvey discovered the circulation of the blood in 1619.

McDowell used a ligature in his first operation of ovariotomy, in December 1809, and brought the ends out through the lower end of the abdominal incision. (The weight of the tumour was 22½ lb., Mrs. Cranford survived the operation and lived for another thirty-one years, to the age of 78.)

Attempts at ovariotomy in England met with a very high mortality and the operation was widely condemned. Tait performed his first successful ovariotomy in 1872, and was denounced as a liar. After years of dispute his statement was accepted.

Meanwhile, Sir Spencer Wells, at the Samaritan hospital, had removed many cysts, with a steady mortality of 25%. He used a clamp on the pedicle and left the clamp protruding from the abdomen.

Tait's mortality was even worse, until he began to use thread as a ligature and returned the stump to the abdomen. Eventually he performed a series of 139 consecutive ovariotomies without a death, a truly remarkable result at that time.

Not only did Lawson Tait place ovariotomy on a firm basis, he is also recognized as being the first man in England to operate upon a hæmatosalpinx, at a time when the very existence of disease of the tubes was denied. He evacuated what looked like menstrual fluid, inserted a drainage tube for three weeks and the patient recovered. Again he was criticized, opposed and disbelieved.

In 1883, Tait operated upon his first ectopic pregnancy, in which the tube had recently ruptured. No counter-claims were put forward for operation on recent rupture; Tait's report was accepted and at last he had the field to himself.

Climbing higher in the abdomen, Tait performed his first successful cholecystotomy for gall-stones in 1879, and this was accepted as the first successful cholecystotomy in England.

Lawson Tait was now accepted as the abdominal surgeon of his day; he was a Scot who adopted Birmingham as his home, and by so doing placed this city in the front rank of surgery. The Tait tradition was inherited by Beckwith Whitehouse and is now in the safe hands of Dame Hilda Lloyd.

Spasmodic Dysmenorrhœa

As far as I know the treatment of this condition has always been uncertain, unsatisfactory, and often a disappointment to patient and doctor. The name means to me, suprapubic pain at the beginning of the period, in a young woman, who possesses the perfect virginal uterus, and nothing abnormal in the pelvis.

In 1913, I was taught the treatment introduced by Mackintosh of Edinburgh in 1842, the only difference being the insertion of a laminaria tent the night before operation. The next day the cervix was dilated to 10 or 12 Hegar dilator and two days later the patient was discharged.

My own difficulty has always been that of deciding how much pain was due to uterine spasm, how much to neurosis and bad training, and how much to pretence in trying to avoid unwelcome activity.

Professor Blair Bell introduced the operation of cutting the anterior portion of the internal os, because of an excess of fibrous tissue in this region, and this was successful in some cases.

In the belief that spasmodic dysmenorrhœa was the only disease cured by labour, a miniature labour was introduced at the Samaritan Hospital. The cervix was dilated to 10 Hegar, and packed with tents for forty-eight hours, when they were withdrawn under anæsthetic. This method produced some cures and about as many failures.

Then the operation of sympathectomy appeared, and a series of cases were operated upon by Mr. Malcolm Donaldson, who reported that 60 to 70% of the patients were relieved of their pain, but added that it was difficult to understand why 30% obtained no benefit. I suspect that in some cases the sphincter at the internal os behaves in a manner similar to the pylorus in hypertrophic stenosis.

In a few cases, dilatation of the internal os has been followed by repeated small incision of the internal sphincter, until No. 12 Hegar passes in and out without expulsive effort. So far the results have been successful.

Carcinoma of the Cervix

Just about 1900, Wertheim introduced his radical hysterectomy, and designed his vaginal clamp. When I first saw this operation in London it consisted of a total hysterectomy with appendages, as much vagina as would allow the application of the clamp, and as much of the paravesical connective tissue as was necessary to remove the ureters from the ureteric canal. If a gland was seen or felt, it was removed.

The next operation I saw was described as Mr. Bonney's method. The vagina was removed for an inch below the growth, the uterosacral ligament was divided close to the sacrum, and the cardinal ligaments were cut close to the internal iliac artery.

In 1920, radium appeared in London, and was immediately used for carcinoma of the cervix, and surprisingly good results were obtained without operation. At this time, a most respected senior announced from the platform that, in future, all pelvic growths would be treated by radiation and that operation would rapidly cease. Great was the dismay of the young men on hearing that their livelihood would disappear almost overnight. But gradually there was a drift back to surgery with or without the previous use of radium.

In 1931, Mr. Goodwin began his block dissection operation with removal of the whole or most of the vagina. In this operation the dissection begins at the periphery; the iliac and obturator glands being removed in one piece with the uterus, vagina and pelvic connective tissue.

On analogy with carcinoma of the breast, this method should be the operation of choice. No one would now think of removing the breast and glands in separate portions.

Mr. Goodwin's mortality is so nearly 1%, that it would be fair to call it such. In Stage I, the five-year survival rate without recurrence is nearly 75%, and in Stage II, about 50%. I offer Mr. Goodwin my personal congratulations on the excellent results of his surgical enterprise.

Six years ago, Brunschwig introduced exenteration of the pelvis for advanced carcinoma of the cervix, which is not adherent to the pelvic walls. In addition to the genital canal, the bladder is removed and sometimes the rectum as well. The ureters are implanted into the colon. The immediate mortality is high and there is often early recurrence of growth. In the combined operation for carcinoma of the rectum, the early mortality was also high, and early recurrence was common. In spite of this, the combined operation is now well established.

The Use of Rubber Gloves

Rubber gloves, now a vital part of our aseptic technique, were first used in 1906 in Leeds by Lord Moynihan. He obtained them from the Middle Rubber Company, Ohio, and they began to reach London, in 1909.

[*November* 28, 1952]

The Amplification and Recording of Fœtal Heart Sounds [*Abridged*]

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When we had made our machine for demonstrating the fœtal heart sounds in various ways, we examined the literature and found that no one has published a description of any machine in this country although various forms of apparatus have been made abroad.

The stethoscope was brought into use for midwifery by doctors very soon after its introduction by Laennec in 1819. Previously there had been only two accounts of anyone listening to the fœtal heart, and these were not written by the people who had listened. The earliest of all is from France. Round about 1650 a group of physicians in Niort spent some years wrangling about the functions of the fœtus. One of them, Phillipe Le Goust, in a poem written in the local dialect, makes fun of his colleague Marsac for claiming to hear the heart of the fœtus "beating like the clapper of a mill".

We can reasonably look upon this as the first written evidence of auscultation of the fœtal heart. If he did indeed hear the heart his discovery was sterile because he did not apply it to diagnosis and prognosis.

The next account, over one hundred and fifty years later, concerns François-Isaac Mayor of Geneva who is generally given the credit of being the first to listen to the heart of the fœtus, and his fame rests on a single footnote. There was published in Geneva a monthly abstract or Readers' Digest called "Bibliothèque universelle des Sciences et des Arts, &c.", and in 1818 the November number records a meeting of L'Académie Royale des Séances in Paris when a report was read on the Treatise of Dr. Lenuce on auscultation. This Dr. Lenuce was almost certainly Dr. Laennec. It described how a committee had verified the author's findings and had also heard the beatings of the heart, the adult heart of course. To this there is an editorial footnote, doubtless inspired by local pride:

" This observation reminds us of one by M. Mayor, the clever Geneva surgeon, which seemed very interesting to us, in his report on the art of accouchements and legal medicine. He has discovered that you can recognize with certainty if an infant, when term is near, is alive or not, by applying the ear to the mother's belly; if the child is alive you hear quite clearly the beats of its heart and you easily distinguish them from the mother's pulse."

On that footnote alone rests the fame of Mayor.

Laennec was the real pioneer; and within a few years (1822) Lejumeau de Kergaradec gave a systematic account of the fœtal heart and of the uterine souffle.

This was the beginning of an epoch when physical signs were coming into their own. Some years later in 1833 Evory Kennedy, of Dublin, described the fœtal heart sounds and was the first to discover and explain the funic souffle.

Observations of the fœtal heart were many; for a great deal more attention was paid to the heart in the nineteenth century than during the first half of the twentieth. Not all the work was accurate. For instance in 1859 Frankenhauser described a sex difference in the fœtal heart-rates, up to 130 for males and over 138 for females and this was still believed by McClintock as late as 1876.

Once the fœtal heart sounds had been heard it was only a matter of time before the need for recording them was felt.

The methods used for recording the heart of the fœtus follow those employed for the heart of the adult. Beginning with tambours and recording drums the investigators passed on to vibrating membranes on which a light mirror was mounted, crude microphones, tracings produced by a smoky flame altered by vibrations, and even a diaphragm consisting of a soap bubble in the centre of which was a thread coated with silver for the movements to be recorded on a photographic plate (Weiss, 1909). Einthoven's string galvanometer and the electrocardiograph followed.

Fœtal Electrocardiography

It has been found that the fœtus *in utero* does create differences in electrical potential which will indeed produce a fœtal electrocardiogram. For example, Bell (1938) working in the wards of the late Professor Hendry in Glasgow, showed that in advanced pregnancy a fœtal tracing is superimposed on the maternal electrocardiogram. The usual leads I, II and III were used. He was not able to use the tracings for any practical purpose. Strassmann and Mussey did similar work in America in the same year. Since then further work has been done in America by Dressler and Moskowitz (1941) and by Bernstein and Mann (1942) on fœtal electrocardiography. They seem to be able to see minute waves on a tracing far better than they can hear a fœtal heart.

Blondheim (1947) introduced a variation by employing the electro-encephalograph to record the fœtal electrocardiogram.

Fœtal electrocardiography should not be confused with the recording of the fœtal heart *sounds*.

Electrocardiography has been used to analyse the quality of the fœtal heart sounds as was done by Paley and Krell (1944). They obtained fœtal electrocardiographs, and stethographs at the same time by using a microphone as well. They described two sounds which were nearly equal, the first sounds sometimes a little longer than the second and each composed of 2 to 4 deflections. These findings are at variance with our analysis done on the cathode ray tube.

The Amplification of the Heart Sounds

Amplification of sounds was made possible by the wireless valve. Major G. O. Squier of the United States Army constructed a heart transmitter in 1921 which made the heart sounds audible in a large room and, in addition, he transmitted them by wireless. Abbott of Purdue University (1923) devised a telephone transmitter tuned so that the adult heart sounds could be heard on a loud-speaker in a large room.

Amplifiers have been used in some of our medical schools to demonstrate adult heart sounds for teaching purposes.

Electrical Amplification of Fœtal Heart Sounds

It was not long after the wireless valve was used to amplify the adult heart sounds that apparatus was devised to magnify the sound of the fœtal heart. Falls and Rockwood (1923) in the United States seem to have been the first to describe a makeshift amplifier which enabled the fœtal heart to be readily counted several feet from the loudspeaker. They were followed by Frederick and Dodge (1924) who used a low pass 130 cycle filter in order to suppress extraneous sounds including the voice and any electrical disturbances. They used multiple circuits connected in parallel to the stethoscopes of the whole class of students. They considered that the energy of the fœtal heart sounds was only 1/50 to 1/500 of the average adult heart sounds.

Sampson and McCella (1926) used valves to amplify with improved tuning and they employed a string galvanometer for recording fœtal heart sounds. They obtained accurate readings of the durations of the first and second sounds and they worked out average durations of systole and diastole.

Hyman in 1930 recorded one of the most substantial pieces of work of this period. His machine called a fœtal phonocardiograph gave tracings as photographic records of the fœtal heart sounds after they had been converted into electro-magnetic waves by radio-amplification. The sounds from the microphone were depicted by a beam of light from a string galvanometer on to a moving film. A sphygmomanometer worked a tambour to give the mother's pulse. Hyman found some gross irregularities of the fœtal heart rhythm. He attached a stethoscope by a rubber girdle and used elephant tubing to carry the sounds to the microphone which passed the signal by a beam of light to the camera. The sphygmomanometer cuff on the brachial artery gave a polygraph tracing simultaneously.

Cioslowski of Warsaw described in 1932 a microphone which could be used with earphones or a loudspeaker.

Bierring, Bone and Lockhart (1935) of Des Moines, Iowa, in their electrostethograph had a somewhat similar type of machine but here the electrical impulses were fed into the moving coil of the d'Arsonval

galvanometer, on which a mirror reflected a beam of light partly on to a photographic film and partly on to a ground-glass screen for the operator to see the vibration. They also passed the sounds into a loudspeaker.

In 1937 Matthews described an amplifying stethoscope which appeared to have been produced commercially and was named the Western Electric 3A stethoscope. As the apparatus becomes more selective and sensitive it is found that the sounds are "fed back" into the microphone and produce a howl. This is a constantly recurring trouble in these machines.

Pommerenke and Bishop of the Department of Radiology of the University of Rochester described their amplifier in 1938 and gave full electrical details. They obtained sufficient amplification of the fœtal heart to make gramophone records. De Costa (1938) described a photostethoscope which gave good amplication of fœtal heart sounds and which carried a neon lamp so that the sounds were translated into flickers of light.

Smith and Hervert (1940) described a cardiophonograph which gave the fœtal heart sounds on earphones or a loudspeaker and they took gramophone records. Smith (1941) describes the recording of a fœtal heart murmur which was confirmed after the birth of the baby. Recently Dunn (1952) of the London Hospital described congenital heart block which was recognized and recorded nine days before delivery.

The Fœtal Heart Machine

The apparatus was made by one of us (M. C. W.) to his own design, to amplify the fœtal heart sounds, to record them in different ways, and in particular to show the trace of the sounds on a fluorescent screen.

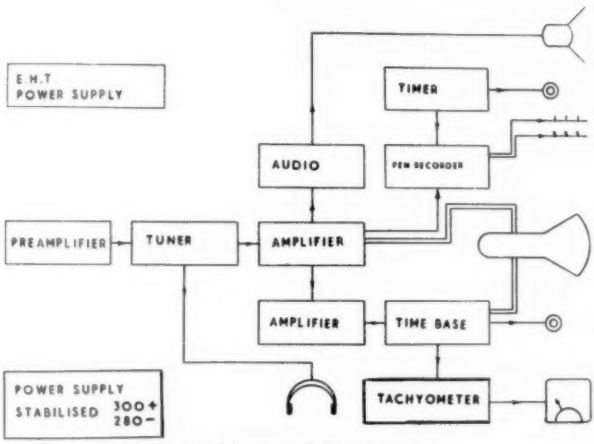

FIG. 1.—Diagram of the apparatus.

Fig. 1 shows the plan of the apparatus. We are using a high gain amplifier that can detect a signal of less than a hundred microvolts, i.e. 100 millionths of a volt, and can amplify it several hundred thousand times without distortion, and at the same time retain a high signal-to-noise ratio. In the apparatus a crystal microphone converts the audible sounds into corresponding electrical impulses. The peak potential received from the microphone at term varies with the intensity of sound, from 200 to 500 microvolts.

The high impedance of the crystal microphone is matched by a cathode follower. The signal received is then amplified through two pentode stages which together form the pre-amplifier. The signal is tuned to whatever frequency is wanted and after further amplification may lead into any of the following channels:

(1) It is heard through earphones which are used both for monitoring and for locating the position where the fœtal heart is heard with maximum intensity.
(2) It is passed through an audio output stage to drive a loudspeaker.
(3) It deflects the Y plates of a built-in cathode ray tube to demonstrate the visual characteristics of the fœtal heart sounds.
(4) It works a pen to provide a graphic record of the fœtal heart sounds.
(5) It passes into a tachyometer to indicate beats per minute on a dial.
(6) After further amplification and clipping, it causes self-triggering of the time base for the cathode ray tube.
(7) It is fed into an external oscilloscope for further inspection and photographing.
(8) It illuminates a neon bulb, each flash indicating a beat.
(9) The audible fœtal heart sounds may be recorded on a wire or tape recorder, or on gramophone records.

A variable thyratron oscillator is incorporated for use as a timer with the pen recorder. In the records shown it marks intervals of one second. It also lights a neon bulb.

The apparatus is housed in a cabinet (Fig. 2). It is an experimental model, in which many of the controls are brought out to the surface. Wartime valves had to be used throughout instead of their modern miniature but expensive counterparts.

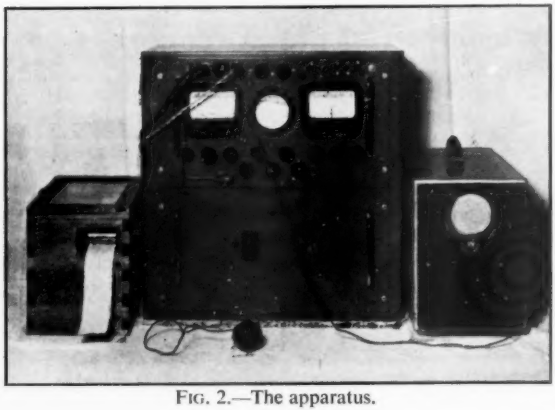

FIG. 2.—The apparatus.

The controls consist of main gain control, tuning control, volume control for speaker, control for pen recorder, regulator of pen path, control of negative feed back, control for size of trace, control for triggering trace, controls for moving spot up and down and from right to left, control for focusing and brightening the spot, control for speed of the time base, control for length of the trace.

The face of the cathode ray tube can be seen in the centre of the apparatus (Fig. 2). The pen recorder is to the left of the metal cabinet and the external oscilloscope for photographing the trace is to the right. The microphone is lying in front of the apparatus.

THE HEART SOUNDS DEPICTED BY CATHODE RAY TUBE

The microphone converts the audible sounds into corresponding electrical impulses. From these the trace on the cathode ray tube demonstrates the visual characteristics of the fœtal heart sounds.

Fig. 3 is a photograph of three fœtal heart beats from one case taken at intervals of approximately half a minute. The strokes seen above the sounds indicate the time-relationship of the sounds, the intervals between each stroke being 1/50 of a second. It can be seen in this case that each beat consists of three large peaks which are followed by four smaller ones which are progressively damped. These three peaks or components are almost identical in size and shape but there are differences. The first component in the first sound is larger than that in the second sound. In the third sound the third component is reduced. The duration of the sound from beginning to end including the damped four peaks is in this case 7/50 of a second. The interval between each of the three large components is slightly over 1/50 of a second.

The small bend of the summit of the middle component is due to the curved surface of the edge of the cathode ray tube.

Fig. 4 shows that the fœtal heart sounds, although differing from Fig. 3, do retain a remarkable likeness. This again shows the three independent components; but the interval between the first and second component is increased and in addition the middle component is considerably larger than the other two. The duration of the whole sound is 9/50 of a second, the interval between the first and second components is 4/50, and that between the second and third components 1/50 of a second.

Fig. 5 shows six sounds recorded from one case and each sound is tuned to the frequency indicated in cycles per second. The pattern remains unaltered, indicating that the higher and lower tones in the sounds are produced simultaneously. These recordings give an idea of the frequencies involved.

Fig. 6 shows three sounds recorded from another case, A was taken before labour, B during a strong labour contraction and C shortly after delivery. There is little change in the overall pattern between the first two sounds, but after delivery the adult appearance was rapidly taken on with two separate sounds: lup-dup. It will also be noticed that there is an accentuated peak associated with the first sound.

Fig. 7 shows the pattern of the baby's heart after delivery. Within an hour of birth there is the adult appearance with two separate sounds: lup-dup.

Our photographs show that the fœtal heart sound is a single beat and has three main components; it extends over a period of approximately 7/50 of a second. As shown in Fig. 4 there may be a longer interval at times between one of the components and the next and thus the sound may appear double to the human ear. We have not been able to confirm the two nearly equal sounds as described by Paley and Krell, nor the systole and diastole which Sampson and McCella measured.

To show the characteristics on the cathode ray tube a self-triggering circuit is employed to activate the time base. The commencement of the first impulse of the sound starts the spot on the screen of the cathode ray tube travelling from left to right; and subsequent impulses in the beat have no effect on the time base until it has traversed a full scan on the screen.

By adjusting the timing, the successive heart sounds can be superimposed one on top of another. Alternatively, the time can be lengthened to show as many as four or five beats on the screen in one

scan. To examine the trace more accurately at leisure, a photograph of it is taken, and for this an external oscilloscope is found convenient. On this we use a single stroke time base (especially made for this operation) with the shutter of the camera open throughout.

To show the time relationship of the fœtal heart sounds a trace on the screen of 50 cycles per second is obtained from either the mains supply or from an oscillator. On a double beam cathode ray tube the fœtal heart sounds and the time traces can be produced simultaneously and photographed. But in this apparatus single beam tubes have had to be used. The traces of the heart sounds and the 50 cycles per second oscillations were photographed separately and later superimposed as shown in Figs. 3–6.

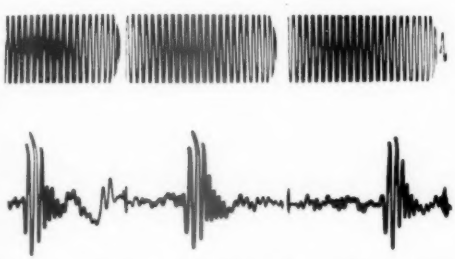

FIG. 3.—Photograph of the trace of 3 fœtal heart sounds on the fluorescent screen of a cathode ray tube. Timer above shows 1/50 second. (× 1/3.)

FIG. 4.—Photograph of fœtal heart sounds of another fœtus showing the three main components but with variations in size and timing. Timer shows 1/50 second. (× 2/5.)

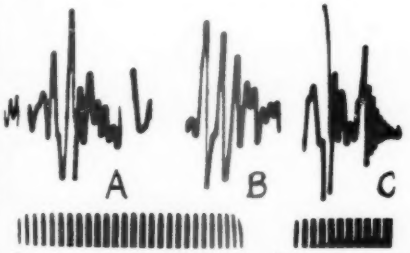

FIG. 6.—Photographs of cathode ray tube traces of three heart sounds from the same case. A, before labour; B, during a strong labour pain; and C, after delivery. The timer shows 1/50 second. (× 9/20.)

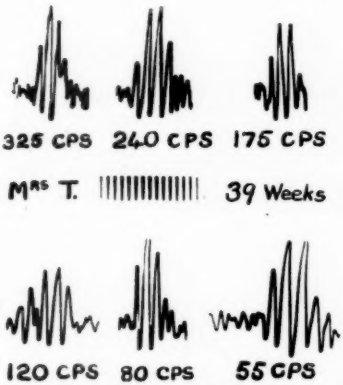

FIG. 5.—Six heart sounds from the same fœtus with the sounds tuned to different frequencies. The timer shows 1/50 second. (× 2/5.)

FIG. 7.—Photograph of the trace on a fluorescent screen of a cathode ray tube of two complete heart sounds of newborn baby. (× 7/20.)

THE RECORDING OF THE FŒTAL HEART WITH PEN ON PAPER

The pen recorder with its timer indicating one mark per second can be left running for a long time to show possible changes in rate and rhythm. It should not be adjusted so sensitively that it responds to the components of each heart sound. We made a trace over a period of 69 sounds extending for 21 inches of paper showing the regularity of the beat. This recording was taken during a uterine contraction. (Not illustrated.)

Fig. 8 shows a trace taken as a uterine contraction was passing off. The interference to the right of the picture is due to borborygmi.

In Fig. 9 the beats marked F are due to fœtal heart sounds, and those marked S are due to the uterine souffle superimposed.

The recording of fœtal heart sounds is not an easy procedure as the signal received from the microphone is small; and sounds from the abdomen, such as borborygmi, and skin noises have a frequency note that is in the same range as the fœtal heart sounds and may cause interference. Mains hum and its harmonic also lie in this range and may be troublesome. The construction of a suitable amplifier necessitated adequate screening and it was necessary to provide a well-stabilized power supply.

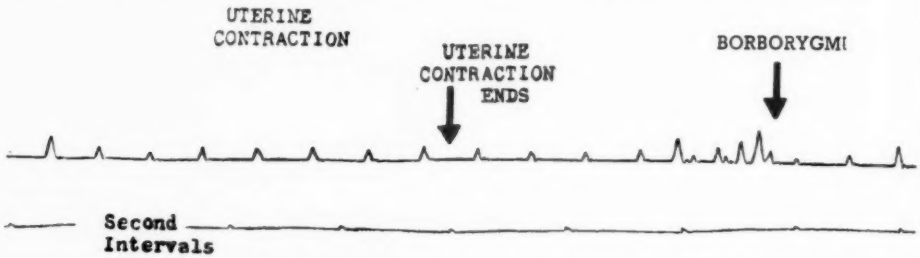

FIG. 8.—A pen record of the fœtal heart sounds with extraneous noises included. (× 3/4.)

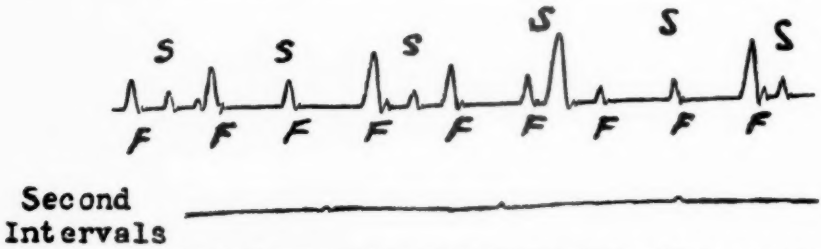

FIG. 9.—A pen record of fœtal heart sounds (F) and the maternal uterine souffle (S). (×1 1/7.)

The only costly component in this machine is the oscilloscope which was necessary in the building of the machine. All other parts were obtained cheaply and many of them were improvised. The apparatus could be improved merely by increasing the cost, and with the knowledge we have acquired by our experience we could improve it in other ways.

We should like to acknowledge the assistance we have received from the medical and nursing staff of the Maternity Department at Lewisham Hospital.

A short film called "Presentation of the Cord" was shown; the apparatus employed demonstrated changes in the fœtal heart-rate.

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Fœtal Distress in Postmaturity [*Abridged*]

By S. G. CLAYTON, M.S., F.R.C.O.G.

TEN years ago it was generally held that the postmature fœtus ran some risk of dying in the uterus before the onset of labour because of degeneration and calcification of the placenta. Miss Masters and I (1940) examined a number of placentæ by three methods: (1) by histological section; (2) by chemical estimation of the calcium content; and (3) by X-ray studies of the calcium deposits. We were unable to find any evidence of degeneration or calcification in postmature placentæ beyond that seen with equal frequency in mature placentæ. Further studies of the fœtal vessels of the placenta by perfusion with radio-opaque suspensions showed no change in postmaturity. On the other hand McKiddie (1949) has recently suggested that the maternal blood flow through the postmature placenta is inadequate.

The fate of the fœtus in postmature cases was also studied (Clayton, 1941) by examining the records of 10,000 consecutive deliveries. Cases in which the pregnancy had continued for more than 42 weeks from the onset of the last menstrual period, and in which the child weighed more than 7½ lb., were selected and compared with 8,552 mature cases. Cases with doubtful dates were excluded. This was not put forward as a definition, but only as a method of separating off a group which was likely to contain most of the postmature cases. (In all later studies the weight criterion has not been used.) 455 postmature cases were available for study and it was found that the stillbirth rate was 6·15% and the neonatal death-rate was 0·44%, whereas the mature cases showed a stillbirth rate of 4·25% and a neonatal death-rate of 1·22%. When the cases were subdivided by weight and maturity the results were less uniform, but still suggested that there was a higher mortality when pregnancy was prolonged.

This conclusion was confirmed by Rathburn in 1943, and McKiddie in 1949. Rathburn did not find that the mortality increased progressively as the duration of pregnancy advanced.

When the causes of the fœtal deaths in the postmature cases were studied the result was unexpected. Among 455 postmature cases there were 28 stillbirths and 2 neonatal deaths, but in all except three of these some obvious cause of death other than postmaturity *per se* was found. If it is objected that the numbers are small it must be remembered that these 3 were the only cases among nearly 10,000 in which death might be attributed to postmaturity alone (in the sense of placental insufficiency). Similar results were obtained by von Ruette (1949) and Latto (1951). Von Ruette studied 1,003 postmature cases and found 28 stillbirths and neonatal deaths, but in all but 4 of these some cause of death other than postmaturity alone was found. It is not affirmed here that the fœtus *never* dies of postmaturity alone—the point made is that genuine cases of death from postmaturity are very rare. As a further illustration of this may be added the fact that no such case could be found in a careful review of every delivery in Queen Charlotte's Hospital in 1942.

In this series it was surprising to find that no intra-uterine death before the onset of labour was recorded in the postmature group. Latto (1951) studied 154 stillbirths and found that 21 fœtuses died *in utero* from no obvious cause, but that only 2 of these were postmature by dates.

Is it possible that the risk of postmaturity has been exaggerated in our minds because of our responsibilities? When an intra-uterine death occurs before term the obstetrician may have little sense of failure as he can often neither foresee nor prevent the accident. On the other hand the postmature case is brought very much to his notice, and if he does not induce labour and the fœtus happens to die then he feels responsible for the disaster, which is invariably attributed to postmaturity.

It may be remarked here that records of the duration of pregnancy in published hospital reports are often very inaccurate. Not only are the dates recorded carelessly—the entry "40 weeks" seems to appear for any case delivered within about two weeks of term—but other errors occur. For example, the fœtus may die before the 42nd week but be delivered after that week, and such cases creep into the postmature series. Reliable reports can only be based on conscientious scrutiny of each case history. A particular difficulty arises with cases reported to be four weeks postmature. Many of these are a full month out in the date of the last period or ovulation, and they obscure and dilute the figures of the few cases which are genuinely four weeks overdue.

With the help of the Records Officer at Queen Charlotte's Hospital an attempt is being made to collect another series of postmature cases, and the present paper only offers some preliminary observa-

tions which relate to all cases delivered in 1950 and 1951 in which pregnancy was reported to have continued beyond the 42nd week. It is hoped to extend this series and ultimately to reach firmer conclusions than can now be offered. No less than 20% of the primiparous cases and 13% of the multiparous cases had to be excluded because of some uncertainty of the evidence, and 356 cases remained in which pregnancy had continued for more than 42 weeks. These were compared with 1,168 cases in which delivery occurred in the 40th week. No relationship between maternal age and postmaturity could be found.

The total fœtal and neonatal mortality in the mature cases was 1·37%, and in the postmature cases 2·81%. The respective percentages of primiparæ were 67% and 68%, so that the figures may be compared fairly. The general improvement in the fœtal results in the ten years since the last series is very great, but there is still a higher mortality among the postmature cases. If it is accepted, on the evidence of this and of the former series, and of the figures of Rathburn (1943) and McKiddie (1949), that the fœtal risk is higher in the postmature cases then we must seek the reason. Is it due to placental inadequacy or to abnormal labour, or to both factors?

There were so few stillbirths and neonatal deaths in this series that detailed study of the causes of death was not very helpful. Again, no death occurred before the onset of labour. 3 out of 10 deaths were unexplained, and these might be attributed to postmaturity; but this is far less convincing when it is found that 3 out of 14 deaths at 40 weeks were also unexplained. In 1949 McKiddie drew attention to the high incidence of fœtal distress in postmature cases, and the present series confirms this. The incidence of fœtal distress or unexplained stillbirth among 783 primiparæ and 385 multiparæ delivered at 40 weeks was 5·6% and 1·3% respectively. The incidence among 243 primiparæ and 113 multiparæ delivered at 42 weeks or later was 12% and 2·7% respectively.

McKiddie attributed the fœtal distress to shutting down of the maternal blood flow through the placenta, and there is good evidence from animal experiments and from studies of the maternal cardiac output that this occurs in late pregnancy. Yet we must not accept this explanation uncritically. The incidence of fœtal distress is much higher in postmature primigravidæ than in postmature multigravidæ, and the changes in the maternal blood flow are presumably identical. It may still be argued that this is because the postmature fœtus with an inadequate blood supply will endure the relatively easy labour of the multigravida, but not the harder labour of the primigravida. But is there any other possibility which may, at least partly, explain the fœtal distress? In 1941 I noted the high incidence of mechanical difficulties and uterine inertia in postmature cases, and the present series shows this even more clearly (Table I).

TABLE I.—DURATION OF LABOUR IN MATURE AND POSTMATURE CASES

	Maturity (weeks)	Weight of child in pounds <6	6+	7+	8+	9+	All cases
PRIMIGRAVIDÆ							
Average duration of labour in hours	40	14·9 (58)	18·7 (226)	18·2 (271)	24·9 (158)	25·0 (24)	19·8 (737)
	42+	11·8 (7)	23·5 (51)	25·3 (96)	25·1 (62)	34·2 (23)	24·2 (239)
Percentage of cases in which labour >24 hours	40	22% (58)	17% (226)	20% (271)	28% (158)	33% (24)	21% (737)
	42+	0 (7)	25·5% (51)	39% (96)	40% (62)	57% (23)	37% (239)
MULTIGRAVIDÆ							
Average duration of labour in hours	40	7·1 (12)	12·6 (81)	8·8 (129)	9·2 (103)	9·6 (32)	9·8 (357)
	42+	8·0 (3)	12·4 (13)	13·8 (43)	12·2 (33)	13·4 (19)	12·9 (111)
Percentage of cases in which labour >24 hours	40	0 (12)	8·5% (81)	5·4% (129)	6·8% (103)	6·3% (32)	6·5% (357)
	42+	0 (3)	7·7% (13)	4·7% (43)	6·1% (33)	21% (19)	8·1% (111)

Numbers of cases in brackets

The incidence of prolonged labour seems to be greater in nearly every primigravid postmature weight group than in the corresponding mature weight group. Even if cases in which there was some mechanical difficulty or disproportion are excluded the same result is found (Table II).

In the multiparous cases the relative increase in the duration of labour was less, and the figures are less reliable as the series is smaller.

Table III relates to instrumental delivery. Many forceps deliveries are performed for fœtal distress, and these cases have been excluded, so that the table indicates the number of cases in which help was needed because of inadequate forces or mechanical difficulty such as an occipito-posterior position.

TABLE II.—PRIMIGRAVIDÆ. *Cases of Prolonged Labour*

Weeks	No. of cases	Labour> 24 hours	Labour> 48 hours	Labour> 24 hours Excluding cases of disproportion and malpresentation	Labour> 48 hours Excluding cases of disproportion and malpresentation
40	737	21%	4·2%	18·2%	3·1%
42	135	33%	8·9%	27·5%	8·1%
43	80	46%	17·5%	41·2%	16·2%
44+	24	29%	12·5%	25%	12·5%

The grouping by weights partly excludes the factor of disproportion, as the cases in any one column are all of the same weight group and roughly comparable.

TABLE III.—PERCENTAGE OF CASES DELIVERED BY FORCEPS OR CÆSAREAN SECTION
(*Excluding Cases in which Operation was Solely for Fœtal Distress*)

Maturity (weeks)	Weight of child in pounds <6	6+	7+	8+	9+	All cases
PRIMIGRAVIDÆ						
40	9·2% (65)	16·4% (244)	14·2% (281)	17·0% (165)	32·1% (28)	15·7% (783)
42+	0 (7)	17·4% (52)	25·3% (99)	32·3% (62)	61% (23)	27·6% (243)
MULTIGRAVIDÆ						
40	6·2% (16)	3·4% (87)	3·6% (140)	10·2% (109)	0 (33)	5·2% (385)
42+	0 (3)	0 (12)	14% (43)	11% (35)	26% (19)	13·3% (112)

Numbers of cases in brackets

The conclusions—or perhaps opinions—to which these observations lead are these:

(1) That unexplained intra-uterine death before the onset of labour is very rare in the postmature cases, and is seen nearly as often before the 42nd week as after.

(2) That fœtal distress during labour occurs more often in the postmature cases than in the mature cases, especially in primigravidæ. The risk could not be shown to increase progressively with the prolongation of pregnancy, but the number of cases is not yet enough to decide this point conclusively.

(3) That the duration of labour is relatively prolonged in the postmature cases, and this appears to be due to abnormal uterine action rather than disproportion. The fœtal distress is at least partly due to this, though the possibility that it is also due to inadequate maternal blood flow through the placenta cannot be denied.

Management of the postmature case.—The uncertainty of the diagnosis of postmaturity is so great that any wholesale method of treatment will lead to much unnecessary induction. Even a drug induction is not entirely without risk to the fœtus if it is too vigorously applied, especially when pituitary extract is used. It is often said that a drug induction is useful as a restless patient feels that something is being done. But if it fails it only increases her anxiety—and it often fails. In the last 50 drug inductions (including pituitary extract) given after the 42nd week no less than 31 failed. In 5 of these cases a second drug induction was given, and there were still 3 failures. This treatment is one which I employ less and less, and I hesitate even more to rupture the membranes for postmaturity. The risk of the fœtus dying before the onset of labour is very small, and possibly less than the small fœtal risk of induction. The risk of inco-ordinate uterine action and of fœtal distress in labour may be increased by induction, though there is no conclusive proof of this in this series as so few cases were induced.

But on one point there should be general agreement. A particularly careful watch for any sign of fœtal distress during labour is required in the postmature case, and any suspicion of fœtal distress would justify immediate delivery, even by section if the second stage has not been reached. In this discussion very little has been said about the factor of disproportion, but mechanical difficulties such as those due to a poorly flexed fœtal head are accentuated by the larger size of the fœtus in the postmature cases, especially if the uterine action is less effective, and this risk must also be remembered.

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Mr. Wilfrid G. Mills (*Birmingham*): There are three clinical features associated with the syndrome of post-maturity, which do not appear to have received adequate notice. They are:

(1) The disappearance of the liquor amnii.

(2) The apparent failure of the baby to gain in weight which may actually progress to a loss of weight *in utero*.

(3) The increased tendency of the baby to develop cerebral hæmorrhage in labour.

(1) *The disappearance of the liquor amnii.*—I believe that when a pregnancy is prolonged beyond whatever is the optimum for that particular baby (that is to say beyond maturity) one of two things may happen. So long as the placenta has an adequate reserve of function, fœtal growth will continue unimpaired, and a large, heavy, hard-headed baby will eventually be born. But when placental sufficiency is exceeded, and the work of Sir Joseph Barcroft has shown that in animals postmaturity is always associated with progressive reduction in oxygen in the fœtal circulation, the child is at once in danger from asphyxia, which may become fatal during delivery. I have induced labour in many women by high rupture of the membranes for no other reason than that 42 weeks had elapsed since the last period, and when there has been an adequate amount of clear liquor, the baby has never been in danger. Occasionally, however, instead of liquor there has been some viscid mucus, often stained with meconium, and in these cases, the state of the child has caused anxiety.

I instance 2 examples. A patient was induced seventeen days over her calculated date having previously had 2 uneventful deliveries of 8 lb. babies. There was no liquor, but thick black meconium flowed out. Labour started at once and the fœtal heart was carefully observed. Its rate remained at 120 but beats were coupled and irregular. Labour was easy and lasted only two hours, when a 9 lb. baby was delivered in profound asphyxia from which it was resuscitated with difficulty. The other case was a primigravida in early labour four weeks beyond her time. The cervix was only 2 fingers dilated but the fœtal heart-rate varied between 92 and 116 and was very irregular. Diagnostic rupture of the membranes showed a viscid fluid stained with meconium, and at Cæsarean section the baby was found covered in meconium, moderately asphyxiated and weighing only 6 lb.

(2) My second contention, that *in extreme postmaturity fœtal growth may cease* and rarely a fœtus may actually lose weight *in utero*, is difficult to prove. The common signs of postmaturity on the baby after birth, the dry cracked skin and the long finger nails, are often associated with good skeletal length but astonishing paucity of subcutaneous fat. Support is given by Hosemann (1948) whose graphs correlating fœtal weight and maturity show an actual decrease in the average weights of babies when gestation is prolonged over three weeks. The most extreme example I have seen was a baby born at least three weeks and probably five weeks over its time. The placenta weighed 1 lb. 5 oz. but the child was only 4 lb. 13 oz. It was gravely asphyxiated at birth, and showed the typical dry cracked skin, long nails and wasted body. It was 19 in. (47·5 cm.) long, and the head had a biparietal diameter of 10 cm. measured on the fourteenth day when the child had just regained its birth weight.

(3) Regarding the *increased tendency to intracranial hæmorrhage* in cases of postmaturity, I was taught that it was a well-recognized occurrence and was due to the hard head which failed to mould in labour. I have seen ample confirmation of the fact, and I recognize that a difficult forceps extraction in a case of post-maturity is more likely to result in cerebral hæmorrhage than an equally difficult case when the child is at term. This bears out the figures published by Clayton (1941) in which he quotes a higher fœtal mortality in postmaturity but finds it due largely to cerebral hæmorrhage after a traumatic delivery. The ætiology might well prove to be the venous congestion which seems to be associated with all forms of asphyxia, and which presumably results in engorgement of the cerebral venous sinuses. This tendency to unexplained hæmorrhage was shown in a young primigravida who was induced when twenty-four days over her time. The fœtus seemed large, but her pelvis was ample and she objected to the induction on the grounds that her mother (whom she resembled closely) had had 10 children and was always three weeks over her time. On questioning the mother this fact was confirmed, but it also appeared that 3 of her babies had been stillborn. The patient was induced, and had a quick and easy labour, delivering a 7½lb. baby that died from cerebral hæmorrhage. As the placenta weighed exactly 2 lb., more than one-quarter of the fœtal weight, it would seem that here again was a baby that had failed to put on weight during its extra time in the uterus. The entire labour took only six and a half hours and an ample episiotomy was performed, so it is difficult to see how an extra hard head could have been a liability to the child.

Conclusion

In postmaturity the danger to the fœtus is primarily the increasing asphyxia that must affect every case of postmaturity if labour does not supervene. I do not anticipate serious trouble so long as there is clear liquor in the amniotic cavity. I will accept postmaturity even when the baby is still small, and I will incriminate postmaturity for death of a baby from intracranial hæmorrhage when delivery has not been unduly traumatic.

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The Oxygen Saturation of Umbilical Artery and Vein Blood at Birth, with Special Reference to Cord Obstruction [*Abridged*]

By C. A. B. Clemetson, M.A., B.M., B.Ch.

Fœtal distress in labour is largely due to fœtal anoxia. There are other causes, such as diabetes mellitus, fœtal trauma, congenital abnormalities, infections and toxins or drugs, but the majority of distressed fœtuses are simply suffering from oxygen-lack, which is loosely termed anoxia.

There is no accurate method of estimating human fœtal oxygen consumption, as this requires a knowledge of the volume of blood flowing in the umbilical circuit per minute, as well as the umbilical artery-vein oxygen difference.

It is, however, possible to obtain some information concerning fœtal oxygenation by analysis of umbilical cord blood samples at birth.

Eastman (1932) has described a type of fœtal anoxia in which the oxygen saturation of the umbilical vein blood is reduced to a very low level. This is true anoxæmic anoxia, where the blood flowing towards the fœtus is poorly oxygenated. I have seen this type of fœtal anoxia on several occasions, but it is another common type of fœtal anoxia occurring in cord obstruction that I wish to describe.

In a study of the oxygen and carbon dioxide content of human umbilical artery and vein blood at birth, the umbilical cord was digitally occluded at each end to arrest the blood flow before the first gasp; Spencer Wells forceps were then applied on either side of the fingers, and a length of cord was isolated by cutting between the clamps.

Umbilical artery and vein blood samples were collected anaerobically over mercury from this isolated segment of cord using a modification of the anaerobic blood sampler described by Austin *et al.* (1922).

Duplicate estimations of the oxygen and carbon dioxide contents of the blood samples collected in this way, were carried out in the Van Slyke and Neill (1924) manometric apparatus, and a specimen of umbilical vein blood was used for oxygen capacity determinations.

In a series of normal vertex vaginal deliveries of non-toxæmic mothers breathing ½% trilene in air, or air alone, there were some babies born with the umbilical cord coiled round the neck, and some where this complication did not arise.

A comparison of the results of the cord blood analyses in these two groups, enables us to assess the effects of "cord round the neck".

Fig. 1. While the umbilical vein oxygen saturation was materially the same in the two groups, 63% and 62%, the umbilical artery oxygen saturation fell from 31% in the normal cases to 6% where the cord was round the neck.

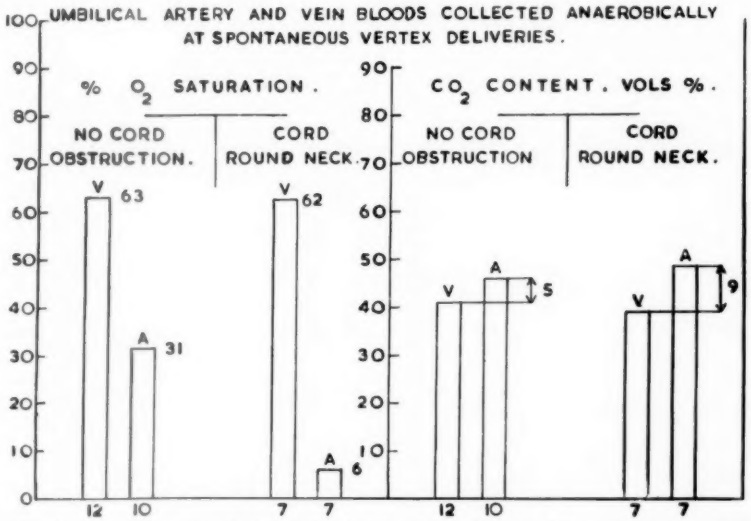

FIG. 1.—Showing the effect of cord obstruction by "cord round the neck" on the oxygen saturation and carbon dioxide content of umbilical artery and vein blood. V = umbilical vein. A = umbilical artery. The number of cases comprising each mean value is shown below the blocks.

The artery-vein carbon dioxide difference was increased from 5 vol.% in the normal, to 9 vol.% where the cord was round the neck; this was due to a rise in the umbilical artery and a fall in the umbilical vein carbon dioxide content. Clearly, both the oxygen and the carbon dioxide results indicate that the fœtal umbilical circuit was slowed by cord obstruction when the cord was round the neck.

No attempt was made to decide whether the cord was tightly or loosely coiled, although this may be important; the cases were simply classed as "cord round the neck" and "no cord obstruction".

We do not know the fœtal oxygen consumption, but we do know something about the oxygen tension of the fœtal tissues; their oxygen tension must be lower than that of the blood which has given up oxygen to them. Since umbilical artery blood consists mainly of that returning from the

upper half of the fœtus, its oxygen saturation is an index of the oxygen tension of the tissues in that part of the fœtus. The umbilical artery oxygen saturation is decreased when the cord is round the neck, so one must conclude that this complication decreases the oxygen tension of the upper half of the fœtus.

The lower half of the fœtus will have an even lower oxygen tension, as it uses blue blood exactly like that in the umbilical artery as arterial blood. This does not mean that all babies born with the cord coiled round the neck will suffer from asphyxia neonatorum. Most of them do not, for they escape in time, but any prolongation of the period of cord obstruction will lead to asphyxia, and may even be fatal.

Harrar and Buchman (1951) attributed 14 out of 38 unanticipated fœtal deaths in the perineal stage of labour to "cord round the neck" alone, so one must not let familiarity with this common complication breed contempt.

So far, I have only mentioned "anoxæmic anoxia" where the umbilical vein blood is poorly oxygenated, and "cord obstruction anoxia" where the flow of normally oxygenated blood is impeded. "Anæmic anoxia" and "histotoxic anoxia" may also occur in the fœtus, but these are less common. In anæmic anoxia there will, of course, be a low oxygen capacity, so that blood with a normal oxygen tension does not carry sufficient oxygen.

In severe histotoxic anoxia one would expect a rise in the umbilical artery oxygen saturation and a fall in the artery-vein oxygen difference, owing to decreased fœtal oxygen consumption. I have not seen this type of anoxia, probably because narcotics were always used sparingly in labour.

It is thus evident that a study of the umbilical vein oxygen content alone gives a very incomplete picture of fœtal oxygenation. The umbilical artery oxygen content and the oxygen capacity of the fœtal blood must also be known before a diagnosis may be reached. Many factors may interfere with fœtal oxygenation, and while our knowledge is far from complete, it is possible to list certain factors according to the type of anoxia they cause (Table I).

TABLE I.—CAUSES OF FŒTAL ANOXIA

Anoxæmic anoxia	*Cord obstruction anoxia*
1. Retro-placental hæmorrhage	1. Cord round fœtus
2. Maternal anoxia	2. Prolapse of cord
3. Severe maternal anæmia	3. True knot of cord
4. Maternal blood pressure drop	4. Breech delivery
5. Cæsarean section factor	5. Short cord
Anæmic anoxia	*Histotoxic anoxia*
1. Erythroblastosis fœtalis	1. Narcotics
2. Fœtal hæmorrhage	

Other factors to be considered

Vascular anastomosis of homozygous twins. Postmaturity. Placental inadequacy. Uterine hypertonus. Uterine retraction. Placenta prævia. Placental infarction. Pre-eclampsia.

Factors such as postmaturity, long labour, uterine hypertonus, placenta prævia, placental infarction and toxæmia of late pregnancy are incompletely understood, but there is evidence (Clemetson and Churchman, 1953) that pre-eclamptic toxæmia simulates the cord obstruction type of anoxia: there may be slowing of the umbilical circuit in this condition due to spasm of the fœtal placental veins; this has indeed been described by Bartholomew *et al.* (1951) as the mechanism of placental infarction.

Fig. 2 shows the results of analysis of umbilical artery and vein blood from three cases which illustrate "normal fœtal oxygenation", "cord obstruction anoxia", and "anoxæmic anoxia".

The first two cases were spontaneous vertex vaginal deliveries, with and without the cord being coiled round the fœtal neck at birth; the third was delivered by Cæsarean section (under cyclopropane and 80% oxygen anæsthesia), performed for hæmorrhage and fœtal distress immediately after a high rupture of the membranes; I have labelled this one placental detachment, for there was little doubt that this had occurred.

At present we rely almost entirely on changes in the rate or rhythm of the fœtal heart sounds for diagnosis of fœtal distress. Intermittent auscultation is a useful guide, but it is not altogether reliable.

Meconium staining of the liquor amnii is even less reliable as a sign of fœtal distress; the funic souffle of cord obstruction, and the tests suggested for diagnosing cord round the neck may also be deceptive, so it is with great hopes that we watch the development of methods for recording the fœtal heart.

The radio-active isotope studies of Flexner and Gelhorn (1942) showed that a volume of water equal to that of the amniotic fluid flows into and out of the amniotic sac of the guinea-pig every hour; this led one to wonder whether the oxygen tension of this fluid would be in equilibrium with that of the fœtal or uterine tissues producing it. However, using the method described by Winkler (1924) for estimating dissolved oxygen in water, I find that amniotic fluid, like urine, contains no free oxygen.

The first principle of treating fœtal distress is, of course, to deliver the fœtus as soon as possible. In theory this is quite simple and straightforward, but owing to the difficulty of assessing the severity of fœtal distress, it is often difficult to know when to interfere.

Whatever method of delivery is adopted, oxygen should be administered to the mother by face mask until the child is born.

Dieckmann and Kramer (1944) took repeated blood samples from a loop of umbilical cord delivered through a small wound at Cæsarean section under local anæsthesia and found that the oxygen content of fœtal blood was appreciably raised by the administration of oxygen to the mother.

Of course, complete cord obstruction or extensive placental separation will prevent oxygen from reaching the fœtus, but as cord obstruction is usually intermittent, and as placental separation is usually partial, there is good reason to administer oxygen in the hope that some will reach the fœtus.

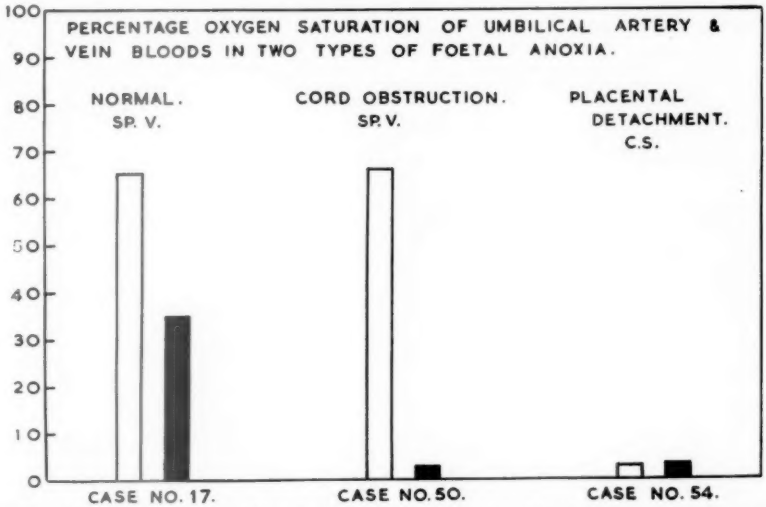

FIG. 2.—Showing the oxygen saturation of umbilical vein and artery blood samples from three cases. The white blocks represent the oxygen saturation of the umbilical vein blood, and the black blocks that of the umbilical artery blood. SP. V. = spontaneous vertex delivery. C.S. = Cæsarean section.

Clinical impressions concerning the value of giving oxygen to the mother in fœtal distress differ widely, but there is no justification for withholding a form of treatment which may do good, and can do no harm.

I wish to thank the Board of Governors of University College Hospital for a grant which made this work possible. Part of this study was carried out while I was a Nichols Fellow of the Royal Society of Medicine.

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Dr. N. R. Butler (University College Hospital): *Prognosis of Fœtal Distress.*

There are several serious dangers, short of fœtal death, which may result from prolonged fœtal distress. Clement Smith (1950) has aptly stated that oxygen-lack may not only stop the machine but also may wreck the mechanism. Even the normal fœtus suffers from oxygen-deprivation in the later months of pregnancy, compensated partly by an increase in the number of red blood cells, which also contain fœtal hæmoglobin with better oxygen affinity than adult hæmoglobin. The fœtal central nervous system is also relatively resistant to hypoxia, which is just as well because the normal developing fœtus probably faces and surmounts a series of asphyxial crises *in utero* which go unrecognized clinically. The fœtal animal can

survive for up to thirty minutes *in utero* with the cord clamped, though Windle *et al.* (1944) have shown that severe fœtal oxygen-deprivation may later give rise to impaired motor and adaptive functions, anyway in the guinea-pig. It is not known how long a human fœtus can survive complete oxygen-deprivation, but there have been well-authenticated cases of survival following fifteen minutes complete anoxia immediately after birth, when anaerobic oxidation of glucose probably provides the central nervous system with sufficient nutrition to ensure survival, if not complete recovery of function.

In the more acute forms of fœtal distress such as that following complete placental separation, rapid fœtal death occurs from sudden asphyxia with the well-recognized post-mortem features of ecchymoses or petechial hæmorrhages on the surface of organs which are usually congested, but may be bloodless if death occurs at once or in the event of cord pressure or occlusion. In the past it was thought that if the fœtus could be delivered rapidly before intra-uterine death, no permanent damage would result, but there is now known to be a short-term danger both to initiation of post-natal respiration and to lung expansion, as well as a potential longer term threat to the development of the central nervous system and mentality. Regarding the lungs, most authorities are agreed that rhythmical though intermittent respiratory movements occur in the normal human fœtus and that there is a circulation of liquor amnii as far down as the alveoli which are thus kept patent following their earlier recanalization. This problem has been clarified by the well-controlled experiments of Davis and Potter (1946) using injections of Thorotrast into the human amniotic cavity before therapeutic abortions and also preceding Cæsarean section at term, proving that the dye became concentrated in the alveoli after absorption of liquor amnii. In the event of fœtal distress, these shallow respiratory movements are replaced by stronger gasps with aspiration into the alveoli of larger quantities of liquor, together with vernix, epithelial debris and even meconium. These may cause an interstitial foreign body reaction difficult to distinguish macroscopically from an intra-uterine bacterial pneumonia. They may also cause cohesion of the alveolar walls with difficulty in initiating respiration, or may even form in some cases a basis for the post-natal formation of a serious so-called "hyaline" or "vernix" membrane. We have analysed 275 cases of fœtal distress occurring in 2,490 live births at University College Hospital in 1950 and 1951 (Table I) and

TABLE I.—CONTRASTING EVIDENCE OF FŒTAL DISTRESS AND POST-NATAL RESPIRATORY COMPLICATIONS IN 2,490 DELIVERIES AT UNIVERSITY COLLEGE HOSPITAL IN 1950 AND 1951

		Post-natal respiratory complication	No post-natal respiratory complication	Total
Fœtal distress	Forceps or Cæsarean section	33	94	127
	Normal delivery	28	120	148
No fœtal distress	Forceps or Cæsarean section	49	190	239
	Normal delivery	82	1,894	1,976
	Total	192	2,298	2,490

have found that 61 (22%) of those babies with fœtal distress also experienced respiratory difficulties at or after birth, either severe enough to require resuscitation or resulting in a delay in establishing regular respiration for a period of five minutes or more after birth. Though less than one in four babies showing fœtal distress actually experienced delay in establishing post-natal respiration, this rate of delayed onset of breathing was nearly three times that occurring in all the live births in the hospital during the same period, emphasizing the need for expert care of such infants immediately after delivery. Of the 275 fœtal distress cases, 148 were delivered spontaneously and the remaining 127 underwent obstetric intervention, by forceps (86) or Cæsarean section (41). It should be mentioned that fœtal distress was not always the primary indication for obstetric intervention in the latter group. Comparing the two groups, the number requiring post-natal resuscitation in the normal delivery group was 28 (19%), as opposed to 33 (26%) in the group delivered by forceps or Cæsarean section. This difference though not enough to be statistically significant may be partly due to a weighting of severely distressed fœtuses in the group undergoing obstetric intervention. It appears that neither the possible adverse effect of general anæsthesia upon an already distressed fœtus nor the fœtal risk inherent in the forceps delivery or Cæsarean section materially worsen the post-natal prognosis in these cases, while early obstetric intervention does undoubtedly reduce the stillbirth rate.

Finally, does perinatal asphyxia carry a serious risk to the ultimate mental or physical development of the child? There are still two schools of thought on this matter. Retrospective studies of children referred for behaviour disorders and abnormalities in the C.N.S. contain a disproportionately high number with a history of birth anoxia. Of the three well-controlled studies so far undertaken Darke (1944) found significant mental retardation in a small series of 19 cases, but Campbell *et al.* (1950) and Keith and Norval (1950) found that no permanent damage occurred in the survivors from perinatal asphyxia. A detailed longitudinal study is needed and with the increasingly accurate methods of diagnosis which have been discussed, babies with fœtal distress should now be given equal prominence with those showing post-natal respiratory delay in studies assessing the long-term prognosis of perinatal asphyxia.

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Section of Orthopædics

President—H. Jackson Burrows, M.A., M.D., F.R.C.S., F.R.A.C.S.

[*October* 7, 1952]

(1) Result of Synovectomy of Hip for Tuberculosis in a Child. (2) Result of Synovectomy of Shoulder for Tuberculosis in an Adult.—M. C. Wilkinson, M.B., F.R.C.S.

The two patients are shown to illustrate the results of partial synovectomy and capsulectomy in the treatment of skeletal tuberculosis. The first patient, a child of 8, had an acute tuberculous hip. She was put on full constitutional treatment and splintage. She was also given ninety days' treatment by the intramuscular injection of 0·25 gramme of streptomycin: 25 injections of filtrate of tuberculous pus were also given. Although the amount of calcification in the hip had improved there had been some destruction of the femoral head, and this threatened the joint function. Five months after admission partial capsulectomy and synovectomy were carried out and an area of ischæmic necrosis in the femoral neck curetted. Tuberculosis was found to be still active in the joint and microscopy confirmed the presence of tubercles. Following operation, her recovery was much more rapid and no further bone destruction took place. On the contrary repair was soon established sufficiently for her to start walking three months after the operation. On follow-up there was good function (Figs. 1, 2, 3).

Fig. 1 (1.2.51).—X-ray on admission, showing ischæmic changes in femoral neck.

Fig. 2 (28.5.51).—X-ray showing progressive changes in head before operation.

Fig. 3.—X-ray after discharge, showing improvement in the joint.

The second patient was a man who during 1950–51 had been treated for a year for tuberculosis of the right sacro-iliac joint. During the course of treatment he had received 90 grammes of streptomycin by the injection of 1·0 gramme daily. Subsequent to his discharge home he developed a swelling in front of the left shoulder and a cold abscess formed in front of the joint, which began

to point under the skin. He was admitted, the cold abscess was curetted and Rimifon 150 mg. daily was given for fifty-one days: during this time the movement of the shoulder recovered partly. However, a few weeks afterwards a sinus began to discharge. A combined course of Rimifon and streptomycin was started and continued for thirty-one days. Early during the course partial synovectomy and capsulectomy were performed. Much caseation and necrosis were found: the cartilage was intact but rough and œdematous. Abundant tuberculous granulation tissue was reported on microscopy. He was discharged with full range of movement six weeks after operation and has kept well since.

The following points about these patients are worthy of note:

(1) Both patients received the most careful constitutional treatment according to the principles which have previously made success in the treatment of skeletal tuberculosis possible.

(2) At operation gross tuberculous changes were present, especially in the second patient, in spite of considerable previous antibiotic treatment.

(3) Some recovery had been made by both patients but this was greatly accelerated by operation.

(4) These operations depend for their safety and success on constitutional treatment and the conditions which have previously been needed for the treatment of skeletal tuberculosis.

Mr. E. T. Bailey agreed with Mr. Wilkinson that one should always aim at obtaining mobile joints, in adults as in children. A fixed joint should no longer be regarded as the only final remedy.

Mr. Wilkinson had mentioned a period of waiting before operation. Was it not possible to operate at an earlier stage still with the aid of chemotherapy?

The President said that treatment of early tuberculosis of major joints by operation combined with antibiotics had aroused universal interest and demanded careful and prolonged follow-up.

Mr. Wilkinson, in reply, said that there was one difference between adults and children. In children the cartilage seemed to go last; it survived for a long time, whereas with adults the results were, so far, disappointing, and the cartilage seemed to go rather early.

He agreed that operation should be performed before destruction of the joint took place. Early operation should be avoided unless there was a threat to the joint, because the operation would be much safer if adequate time were allowed for proper constitutional treatment. The introduction of constitutional treatment for skeletal tuberculosis thirty years ago was a greater advance than the introduction of antibiotics at the present time. The antibiotics might well reopen possibilities of surgery to save function.

Six Cases of Arthroplasty of the Hip in Amputees.—LEON GILLIS, M.B.E., M.Ch.(Orth.), F.R.C.S., F.R.C.S.Ed.

The operation of arthroplasty of the hip by replacement with a prosthesis is now becoming a common procedure.

I have used a metallic prosthesis for some time now, for all cases of hip arthroplasty including amputation cases.

The 6 cases herein presented demonstrate the use of such a prosthesis in patients with osteo-arthritis of the hip on the same side as the amputation, on the side opposite to the amputation and in double amputations, both above and below the knee.

I.—D., aged 57. (Figs. 1 and 2.)
October 1951: R. above-knee amputation. L. below-knee amputation due to a mining accident.
Left flexion adduction deformity due to osteo-arthritic changes.
This prevented him being fitted with an artificial limb.
26.6.52: Arthroplasty L. hip.
Has been fitted with two short rocker limbs and is now walking.

II.—J. B., aged 54.
1918: Gun-shot wound L. leg and above-knee amputation.
1948: Onset of significant pain in L. hip.
1952: Unable to wear artificial limb for a whole day's work.
17.7.52: Arthroplasty L. hip.
1.10.52: Wearing pylon and getting about well.

III.—S., aged 51.
Buerger's disease.
1946: R. above-knee amputation.
March 1952: L. below-knee amputation.
August 1952: Fractured neck of right femur after a fall. Excision of head and metal prosthesis replacement.

IV.—M., aged 59.
1917: R. Stokes-Gritti amputation following gun-shot wound.
1940: Onset of pain and stiffness L. hip.
1952: L. hip fixed flexion and external rotation deformity.
August 18, 1952: Arthroplasty L. hip.
Now walking on crutches. No pain.

FIG. 1 (*Case I*).—Skiagram showing gross osteo-arthritis of the left hip with adduction flexion deformity.

FIG. 2 (*Case I*).—Arthroplasty of the same hip by replacement of arthritic femoral head with stainless steel prosthesis, and correction of deformity.

V.—B., aged 50.

Air-raid casualty. R. below knee amputation 1947. Stump unsatisfactory. Above knee amputation in 1948. Wore artificial limb but by January 1952 had to discontinue limb wearing because of pain in the hip. Flexion contracture present.

1.5.52: Arthroplasty R. hip.

August 1952: Wore artificial limb. Now at work.

VI.—R., aged 62.

1918: Gun-shot wound R. leg. Right above-knee amputation.

1951: Pain in R. hip sufficiently severe to preclude limb wearing.

27.5.52: Arthroplasty R. hip.

26.9.52: Re-started artificial limb wearing.

Post-operative care.—Since in amputation cases the usual traction in balanced canvas slings is impracticable, the likelihood of dislocation at the hip is assessed before the patient leaves the theatre. If it is likely to dislocate, a plaster spica is placed on the stump for three weeks. Otherwise, a spica crepe bandage is sufficient. The stitches are removed in three weeks, and more vigorous muscle exercises continued for a further two weeks, after which the patient returns to his artificial limb, and walking usually becomes free of pain.

Acrylic Arthroplasty of Interphalangeal Joint.—F. G. WARD, F.R.C.S.

W. P., aged 31. Civil Engineer.

On January 11, 1952, whilst playing Rugby football he dived into a loose scrum and injured his right middle finger.

On February 11 he was referred to the Orthopædic department, Ashford Hospital, previous reduction of dislocation having "failed". Clinical and X-ray examination showed an unstable fracture-dislocation of the proximal interphalangeal joint. Reconstruction of the base of the middle phalanx was considered impracticable (Fig. 1).

With the assistance of the dental mechanic a clear acrylic prosthesis was modelled from a cadaver's phalanx and from an X-ray of the middle finger of the left hand. The dorsal surface of the prosthesis was made flat to prevent rotation.

At operation on February 28 the proximal interphalangeal joint was exposed by a lateral incision and completely dislocated after division of the proximal attachment of the collateral ligament and capsule. The base of the phalanx with the exception of the dorsal lip was replaced by the acrylic prosthesis (Fig. 2).

After a week in plaster incorporating middle and index fingers in the position of function and three weeks with the two fingers strapped together, free use was permitted with physiotherapist's encouragement.

Recovery of function was quicker than expected and seven weeks after operation extension of the finger was full, flexion was to the right-angle, the joint was stable and full power had returned to the finger. Since then he has used the hand normally and has confessed to using a 7 lb. hammer. He has played cricket and has resumed Rugby football which he plays with the middle strapped between index and ring fingers. Function is unchanged since April and a recent X-ray shows the radiolucent outline of the prosthesis with an organized layer of new bone in front of the head of the prosthesis which serves further to stabilize it (Fig. 3).

FIG. 1.—X-ray of finger taken 29.2.52, lateral view.

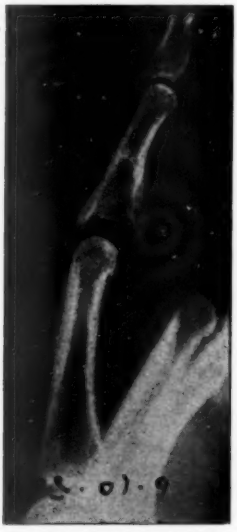

FIG. 3.—X-ray of finger taken 6.10.52, lateral view.

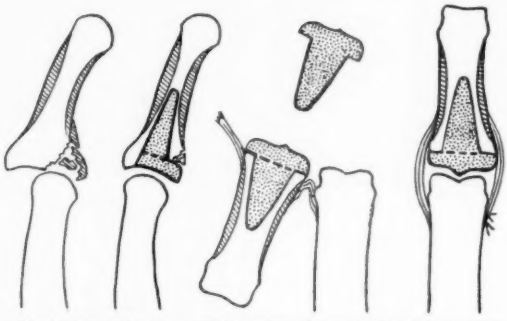

FIG. 2.—Diagram illustrating: Fracture dislocation of proximal interphalangeal joint; acrylic replacement of the base of the middle phalanx.

This arthroplasty was performed under the favourable circumstances of fairly recent injury, with little periarticular contracture, in a patient of superior intelligence and good morale who was prepared to lose the finger should the operation fail. It demonstrates that acrylic arthroplasty in a finger can be a practicable procedure.

Endler and Stadler (1950, *Wien. med. Wschr.*, **100**, 96) report favourably on four similar arthroplasties for hallux rigidus. I have since had one failure for hallux rigidus in a patient aged 13.

Mr. P. Wiles congratulated Mr. Ward on this very fine result. It was unusual to have full recovery of function of the fingers after nine weeks, even without a fracture, but to have achieved it in a case such as this was a very remarkable thing. Others had tried out the method without a great deal of success; perhaps the reason Mr. Ward had succeeded was that the operation was performed so soon after injury.

Osteochondrodystrophy (Brailsford, Morquio).—G. G. FARRINGTON, F.R.C.S.

R. W. C., male, aged 14 years. Referred to Dr. Harold Avery with the complaint that his legs were weak and did not seem strong enough to support him. First noticed by parents two years ago and more marked now though he can run upstairs.

Past history.—Normal birth and early development. When about 5 years old it became apparent that he was small for his age. He is still growing, though slowly. No serious illnesses.

Family history.—No known consanguinity. Nil relevant.

Examination.—Alert and intelligent. Undersized boy, looks about 7–8 years. Height 52 in. Weight 60 lb. Limbs thin but no gross wasting or weakness. Barrel chest. Round shoulders. Mildly kyphotic and some pes valgus. Head normal in shape and size. Joints normal. C.N.S. and C.V.S. normal. General appearance is that of osteochondrodystrophy (Fig. 1).

FIG. 1.—Osteochondrodystrophy (Case R. W. C.)

FIG. 2.—X-ray of same case showing the characteristic deformity of the lumbar vertebræ.

X-ray appearance (Fig. 2).—Bodies of lumbar and lower dorsal vertebræ irregular in shape and outline and markedly narrowed anteriorly. Acetabulum somewhat irregular in outline. Other joints normal.

Comment.—A case of osteochondrodystrophy. The radiological changes are limited to the vertebral column and hip-joints as in Brailsford's Group C (Brailsford, 1944).

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Osteopoikilosis (Familial Disseminated Osteosclerosis).—G. R. FISK, M.B., F.R.C.S., F.R.C.S.Ed.

This condition is characterized by collections of dense opaque spots in the spongiosa of the bones chiefly accumulated at their extremities. At this level the areas are roughly circular but where they extend into the shaft the opacities become oval or striate. The whole skeleton may be involved, but the skull, spine and ribs are usually unaffected. The condition is hereditary, males being more frequently affected, and is symptomless.

It was first recognized by Stiede in 1905 and more fully described by Albers-Schonberg in 1915. In 1928 Buschke and Ollendorff described an associated skin lesion which they called "dermatofibrosis lenticularis disseminata". This consists of symptomless papules distributed symmetrically over the posterior aspects of the trunk and limbs.

Microscopically the areas show that the increased density is due to numerous juxtaposed trabeculæ more resembling the spongiosa than the cortex (Schmorl).

Case report.—A seaman, aged 26, who injured his right shoulder in July 1952 attended hospital in Brisbane where routine X-rays showed multiple sclerotic patches in the head of the humerus and glenoid. Further

X-rays taken on his arrival in this country revealed similar changes in the other shoulder, both wrists, hips, pelvis and to a lesser extent the knees. The skull was normal. (Figs. 1, 2, 3, 4.)

Investigation of the blood chemistry showed:

Serum calcium, 9·0 mg.%.
Serum phosphate, 1·8 mg.% inorganic phosphates.
Plasma alkaline phosphatase, 2·3 (King-Armstrong) units.
Plasma uric acid, 5 mg.%.
Wassermann, Kahn, and gonococcal fixation tests, all negative.

He is of rather small stature, which feature Busch (1937) noted in his cases, otherwise he is quite normal. There is no associated skin lesion. There is no known family history.

FIG. 1.—Left hip.

FIG. 2.—Right shoulder.

FIG. 3.—Left hand.

FIG. 4.—Right knee.

Discussion

The cause of osteopoikilosis is unknown. It has been described in association with many other conditions (e.g. typhoid) but none of them sufficiently consistently to be of significance.

Nichols and Shiflett (1934) described a case of undoubted osteopoikilosis with multiple osteomata and Hinson (1939) published an example showing cystic changes in the sclerotic areas. Voorhoeve (1924) "thought that dyschondroplasia, osteopathic striata and osteopoikilosis were due to the same fundamental process" (Fairbank, 1951). One interesting suggestion is "that the condition may be related to the arterial system as the general distribution follows that of hæmatogenous tuberculosis in the bones" (Hinson).

It is undoubtedly hereditary being carried by a recessive gene. It is probably commoner than the literature would suggest since nearly all the cases described have been discovered by chance X-ray examination.

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Lesion of Left Ilium.—D. L. Evans, F.R.C.S., for T. M. Prossor, F.R.C.S.Ed.

P. C. H., male, aged 40.

16.9.52: He had an attack of typical left renal colic. There was no previous history of kidney trouble. Straight X-ray of renal tract revealed large osteolytic lesion of left iliac bone.

1.10.52: Admitted to hospital. Appeared well.

On examination.—There were no abnormal physical signs. Chest X-ray revealed early pulmonary tuberculosis. (All other investigations were normal.)

13.10.52: *Biopsy:* There was a smooth-walled cavity in the left ilium, containing indefinite tissue. *Histology:* Normal bone and bone-marrow.

The patient is under sanatorium treatment for his pulmonary tuberculosis. He remains otherwise well.

The diagnosis is not established.

Neoplasm of Upper End of Left Femur.—D. L. Evans, F.R.C.S., for Sir Stanford Cade, K.B.E., F.R.C.S.

P. L. H., male, aged 19.

March 1952: He fell and hurt his left hip. It ached occasionally for the next four months.

July 1952: *On examination.*—No abnormal physical signs. His pain was relieved by physiotherapy.

August 1952: The pain became more severe especially at night. It extended down the thigh and into the calf.

The muscles were wasted and movement of affected limb was restricted. There was no fever.

X-ray examination.—Femur: Normal. Chest: Old healed tuberculosis. *E.S.R.* (Wintrobe): 48 mm. in the first hour.

He was treated as a case of tuberculous arthritis and a course of streptomycin was started.

September 1952: Large hard painless swelling. X-ray showed marked changes in upper part of left femur, which were considered to be neoplastic.

October 1952: There was clinical regression, with increased movement of the hip. X-ray showed little change. The clinical and radiological appearances were consistent with an osteomyelitis, modified by chemotherapy.

13.10.52: A *biopsy* was performed. The histology was reported as ? Ewing's tumour.

October–December 1952: Course of deep X-ray therapy.

January 1953: There is remarkable clinical improvement. X-ray shows some re-ossification—otherwise little change.

During the discussion the importance of clinching the diagnosis, if necessary by biopsy, before embarking on a line of treatment was emphasized by several members.

The following cases were also shown:

Osteotomy of the Spine and Arthroplasty of the Hip, in a Previously Bed-ridden Case of Ankylosing Spondylitis.—Mr. J. D. Cronin.

Fanconi's Syndrome Treated by Massive Doses of Calciferol and Two-Stage Tibial Osteotomy.—Mr. M. Singer. (This case may be published later in the *Post-Graduate Medical Journal.*)

Pathological Dislocation of Right Hip, Destruction of Lower End of Left Femur—the Result of Neonatal Septicæmia.—Mr. G. M. Bedbrook and Mr. I. M. Robertson.

Gross Bilateral Arthritis of Hip-joints.—Mr. H. E. Harding.

[*November* 4, 1952]

SYMPOSIUM ON PROBLEMS OF FRACTURES IN THE AGED

Mr. R. H. Metcalfe, Consultant Orthopædic Surgeon, St. James' Hospital, London: There is unfortunately, at the present time, a tendency to disregard the human approach in the treatment of all diseases, and, as Sir Harry Platt said, orthopædic surgeons are in danger of becoming mere "garage mechanics". The treatment of the disease or injury in all patients is naturally an essential, but it must be realized that unless the patient is treated as an individual, and not merely as a "case" of disease or injury, the eventual recovery may well be delayed or incomplete. This concept is especially of importance in the treatment of fractures in the aged. These old people, drawing to the end of their lives, have a natural fear of death, of the immediate future and of what may happen to them on their discharge from the hospital. The only way to combat this fear is to restore the confidence of the patients.

First impressions on arrival in the ward are of the utmost importance, a smile on the face of the Sister or a Nurse and a cheerful welcome from the other patients are essential. The patient's bed should, if possible, be placed next to a patient with a similar injury, well on the way to recovery. There are many ways in which happiness can be brought into a ward, simple things like the provision of a birthday cake by the hospital kitchen gives great delight to an old person and makes him, for one day, the centre of attraction. Patients should be told what is the matter with them and a simple explanation given as to the treatment they are to undergo. Unfavourable signs and symptoms must not be discussed in the ward as the "grape-vine" is stupendous. Many old people enjoy nothing more than discussing and comparing their illnesses.

The old voluntary hospitals, many of which were founded on religious foundations, had morning prayers in the ward every morning and this still continues. Recently at St. James's Hospital I have revived this wonderful system and I now start my ward rounds with a simple prayer, in which the patients join, asking for God's help towards their recovery.

After operation, the next essential is to obtain mobility by morning exercises, organized on the class principle under the supervision of a physiotherapist. This mobility can be continued throughout the day by means of "knee-oil", which the patients rub daily into their knees themselves. This gives wonderful exercise to all parts of the body, especially the abdomen and I am sure this is largely the reason why constipation is almost unknown in my wards. Competition is encouraged and incentive is given to the patients when they start to walk by such a simple device as a bracket on the wall at the end of the ward on which something different is placed every day.

Old people who come in with a fracture often live alone and have not had a real meal for many years. It is often difficult for them to adjust themselves to the larger meals in hospital, although this must be done, as without adequate nourishment the healing of the fracture is undoubtedly delayed. The addition of beer or Guinness, if desired, and extra milk often helps.

Finally comes the question of disposal. Old men frequently find some old lady willing to look after them, but old ladies are set in their ways and find it difficult to live together in harmony. In some hospitals the relatives are asked to sign a form stating that they are willing to take their relatives back into their homes. Unfortunately this bond is frequently broken and the old person is "written off". With the increasing average age of the population the hospitals for the chronic sick are now inadequate. The solution may be the provision of more old people's homes of which there are already a large number in all parts of the country, run either by charitable Societies or by Local Authorities. In these homes old people of both sexes live together in great happiness, they pay what they can afford, the rest being provided by grants from local authorities and the Ministry and about 10% by voluntary contributions.

Membership of a Darby and Joan Club, or the use of Social visitors, is a great help to prevent loneliness. Old people should be put in touch with such activities before they leave hospital.

Mr. J. A. McLauchlan, Consultant Orthopædic Surgeon, Queen Mary's Hospital for the East End: *Upper extremity.*—During the past three years I have seen 345 fractures and dislocations of the upper extremity in patients over the age of 65.

TABLE I.—FRACTURES OF THE UPPER EXTREMITY

Bone	Average age	Male	Female	R. side	L. side	Total
Clavicle	74·5	4	6	5	5	10
Scapula	71	4	7	9	2	11
Humerus	73	29	44	31	42	73
Radius and ulna	72	33	167	91	109	200
Carpus	69	1	2	3		3
Metacarpus	71·4	6	12	8	10	18
Phalanges	70	13	7	11	9	20

There were three pathological fractures—a male, aged 67, with a primary reticulum-cell sarcoma of the left humerus; a male, aged 73, with Paget's disease of the left radius; and a male, aged 65, with a parathyroid adenoma and a fracture of the left radius.

There were two deaths—a male, aged 67, and a female, aged 74.

95 injuries, including 22 dislocations of the shoulder, occurred in the shoulder region (Table II).

TABLE II.—INJURIES IN THE SHOULDER REGION

Site of fracture	Average age	Male	Female	R. side	L. side	Total
Clavicle	74·5	4	6	5	5	10
Acromion	74·5	2	2	3	1	4
Glenoid	72·5	1	3	4		4
Body of scapula	66	1	1	2		2
Coracoid	70		1		1	1
Dislocation of acromio-clav. joint	74		1	1		1
Dislocation of shoulder-joint	77	8	14	14	8	22
Gt. tuberosity	71	4	7	8	3	11
Surgical neck of humerus	76·3	18	22	13	27	40

Fractures of the clavicle were treated by a figure of eight bandage and early active movements. 5 had some limitation in movement of the shoulder. 4 involved the outer third of the bone and 1 was complicated by rupture of the middle and inner coats of the third part of the subclavian artery.

Of the dislocations of the shoulder 6 were associated with fractures of the greater tuberosity of the humerus, 4 with fractures of the glenoid fossa, 3 with fractures of the surgical neck of the humerus, and 2 with injury to the radial nerve. Only 1 required operative reduction. All were treated in a collar and cuff and early active movement was the rule. Those with complications had limitation in movement and pain.

FRACTURES OF THE GREATER TUBEROSITY OF THE HUMERUS

Half were associated with dislocation of the shoulder. All were treated in a collar and cuff and by early active movement. Those with displacement had some residual stiffness of the shoulder.

FRACTURES OF THE SURGICAL NECK OF THE HUMERUS

All were treated in a collar and cuff and by early active movements. 30 were impacted and of these 25 had a full range of shoulder movement without pain. 10 were complicated by dislocation of the shoulder, adduction of the lower fragment, fracture of the greater tuberosity or injury to the radial nerve. Of these only one had a fair range of shoulder movement.

TABLE III—FRACTURES OF THE SHAFT OF THE HUMERUS

Average age	Male	Female	R. side	L. side	Total
72	4	7	7	4	11

All united although in 4 there was some delay. 4 had internal fixation. All had some residual stiffness of the shoulder.

TABLE IV.—FRACTURES IN THE REGION OF THE ELBOW

Site of fracture	Average age	Male	Female	R. side	L. side	Total
Supracondylar	69	2	5	4	3	7
Med. epicondyle	77	2			2	2
Lat. condyle	72		2		2	2
Olecranon	72	2	4	4	2	6
Head of radius	68	1	2	1	2	3

All supracondylar fractures were without displacement and all had severe osteo-arthritis of the elbow-joint. One of the fractures of the medial epicondyle was due to a primary reticulum-cell sarcoma. In one instance a fracture of the olecranon was associated with a comminuted fracture of the head of the radius. The head was excised and the olecranon wired. This patient recovered full function of the elbow.

TABLE V.—FRACTURES OF THE SHAFT OF THE RADIUS

Site of fracture	Average age	Male	Female	R. side	L. side	Total
Upper third	69	2			2	2
Lower third	70·5		2	1	1	2

The two fractures in the upper third were pathological—Paget's disease and parathyroid adenoma. All fractures were treated in a plaster cast and all recovered full function.

Fractures of the Shaft of the Ulna

There were three fractures of the lower third of the shaft of the left ulna. They occurred in females whose average age was 76. All united with good function.

Table VI.—Fractures of the Wrist and Hand

Fracture	Average age	Male	Female	R. side	L. side	Total
Colles' fracture	73·5	25	152	81	96	177
Lower end of radius	71	4		1	3	4
Radial styloid	70	1	2	3		3
Scaphoid	69	1	2	3		3
Metacarpus	71·4	6	12	8	10	18
Phalanges	70	13	7	11	9	20

Colles' Fracture

In 30% no reduction was required. Some 10% had comminution of the lower fragment with involvement of the articular surface. Only one was complicated by rupture of the extensor pollicis longus tendon. There was considerable bone atrophy in 6. All were treated in a plaster cast and by early active movements of fingers, elbow and shoulder. There was some slight residual deformity in 50%. Those with comminution of the distal fragment did not recover full movement of the wrist and had some degree of pain. In the aged pain is a greater disability than restriction of movement and, generally, some restriction of movement of the wrist without pain is preferable to a full range of movement with pain. Good results and full function of the wrist without pain were regained by 60%. Fair results with limitation in movement or pain were obtained in 28%. Poor results with limitation in movement and pain occurred in 12%.

Fractures of the Metacarpus

Of the 18 fractures of the metacarpus 12 involved the fifth metacarpal and 5 the fourth. There was little displacement. All were treated by a bandage and early active movements. All recovered a full range of movement.

Fractures of the Phalanges

The terminal phalanx was affected 11 times, the proximal phalanx 6 times and the middle phalanx thrice. In only 3 cases was full mobility not attained.

Conclusion

In this series all the fractures united. We may therefore conclude that non-union in fractures of the upper extremity in the aged is not usual. The main problem is the prevention of a stiff and painful shoulder. In a lesser degree this applies to the elbow, wrist and fingers also. This is best solved by early active movements even if this means some inadequacy of reduction.

Mr. E. Mervyn Evans, Consultant Orthopædic Surgeon, Glantawe and West Wales: *The treatment of fractures of the upper end of the femur in the aged.*—In the over-70 age group the fracture itself is of secondary importance, except in so far as it is a cause of pain and enforced immobility. Old people do not tolerate these well; they are quick to become irrational or incontinent, to develop bedsores or pulmonary complications, and associated diseases are often present, the treatment of which is hampered by the immediate consequences of the fracture. Thus, the primary object of treatment must be the relief of pain, and the restoration of mobility, and, if it can be shown that operation is safe, then internal fixation is surely the most efficient way of achieving this object. The truth of this has long been recognized in sub-capital fractures, but in the trochanteric group opinion is divided, although the pain and bruising are usually greater, and the average age a decade higher.

The case for operative treatment of trochanteric fractures may be put under four headings:

(1) Lowered mortality.

(2) Greater comfort and mobility.

(3) Better functional results.

(4) Economy of beds.

The comparative mortality rates are the crux (Table I), and I would quote two consecutive series, one of cases treated conservatively, the other by operation.

TABLE I.—TROCHANTERIC FRACTURES

Method of treatment	Number of cases	Average age	Average time in hospital	Mortality %
No beds available: Discharged home ..	25	77	—	44
Conservative treatment	101	62·2	15 weeks	15
Operative treatment. Capener nail-plate ..	110	74·3	4·9 weeks	10·9

Conservative series (1942–48)—101 *cases.*—Average age: 62·2. This is low, and suggests some selection. In fact, 25 cases were traced as having been sent home during part of this period because of shortage of beds; the mortality in this series within three months was 44%.

Mortality within fifteen weeks: 15%.

Length of stay in hospital: fifteen weeks.

Operative series (*nail-plate fixation* 1948–49)—110 *cases.*—The series was unselected; all cases seen were admitted, and all were operated upon.

Average age 74·3.

Mortality (within five months) 10·9%.

Length of stay in hospital 4·9 weeks.

It may be argued that complications are more common after operation, but this was not so. Only 1 in 110 died of a pulmonary complication (embolus), and there were only 2 cases of severe respiratory infection—a remarkable figure, considering the high incidence of associated pulmonary diseases. Some complications are peculiar to operation, but the only one which occurs with any frequency is coxa vara (24 cases). The incidence is the same as in the conservative series, and I do not believe that the method of treatment has any bearing on the development of the deformity. It will occur in all cases in which the inner cortical buttress is destroyed, or in which reduction of cortical overlap has not been achieved.

The greater comfort and mobility after operation cannot be denied. Free mobility is present within a few hours, and the patient sits out of bed on the first post-operative day. The claim for improved function is difficult to prove, but I believe that function is better after operation. 63 out of 98 survivors had virtually full hip function, and in only 8 was there considerable restriction of movement. Knee function was even better, particularly when one considers the effect of traction on the aged knee-joint—only 3 out of 98 with less than 180 to 90 degrees.

In the treatment of trochanteric fractures by nail-plate fixation:

(1) The operation should be regarded as an emergency, with adequate facilities available.

(2) A small blood transfusion is given to all aged patients, to combat general debility as much as blood loss.

(3) Aspiration of mucus from the trachea by endotracheal tube at the end of the operation seems to have contributed to the low incidence of pulmonary complications.

(4) In linear fractures the rotational position is unimportant. In comminuted fractures, the fracture having been caused by external rotation violence, the limb must be put up in external rotation to close the gap. In these more difficult cases the limb should be placed in about 20 degrees external rotation, and this amount increased if necessary until a pinnable position has been obtained.

(5) Perhaps the most important point is the realization of how these fractures differ from fractures of the neck of the femur. The insertion of a Smith-Petersen nail must be a precise affair, with careful judgment of the length and placing of the nail. In trochanteric fractures the nail-plate has but to hold the neck and shaft together in order to permit early mobility. The nail must not be too long nor placed too high and the reduction must be such as to make nailing possible, but there is much latitude. The emphasis is on the patient and not on the fracture, for an early and swift operation and the immediate resumption of mobility may be life-saving measures.

(6) Immediate weight-bearing may be permitted in trochanteric fractures, where cortical stability has been restored. In the remainder it is best delayed for several weeks. Mobility, however, is essential, and many an aged patient will be unable to manage crutches without putting the affected limb to the ground. In some of these, both in the trans-cervical and trochanteric groups, the advantages to be gained by early ambulation will far outweigh the risks incurred, and early weight-bearing may be permitted.

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Mr. **J. G. Bonnin**, Consultant Orthopædic Surgeon, Central Middlesex Hospital: *Fractures of the femoral neck in the aged.*—It has been shown that in pertrochanteric fractures the early mobilization which can follow a pin and plate makes this procedure well worth while. It seems logical to extend this benefit to subcapital fractures. There is often a general reluctance to get the patient with a subcapital fracture weight-bearing shortly after the operation.

There are three main elements which prevent the surgeon from permitting early weight-bearing. Firstly, there is the fear of separation at the fracture line. Weakness here is due to inadequate reduction, bad pinning, a failure of adequate impaction and the angle of the fracture (Pauwels). If a technically satisfactory pin is inserted immediate post-operative weight-bearing is possible. In less satisfactory pinnings weight-bearing can be delayed or reduced by the use of crutches. Secondly, the occurrence of avascular necrosis. This is largely determined by the damage done at the time of the accident. The chief factor influencing it subsequently is the time of reduction which, by reducing soft tissue tensions, may aid early restoration of circulation. Weight-bearing may result in early signs of head collapse but cannot influence the occurrence of the tragedy. Thirdly, non-union. This is closely related to the fear of separation of the fracture surfaces. If they do separate, non-union or delayed union is likely to occur. Occasionally weight-bearing, by closing up the gap between the head and neck, may actually hasten union. Impaction is, in general, more important than position and for this reason it is better to nail the head in slight posterior rotation and excessive internal rotation in reduction is undesirable.

Early weight-bearing has now been practised in suitable cases for four years and 40 cases have been followed up. The average stay in hospital was seven and a half weeks. The date which the patient was allowed to bear weight varied from two to six weeks and this was dependent on the weight of the patient, the recovery of the muscular control with bed exercises, and the efficiency of the pin, judged radiologically.

Although accurate comparison with other surgeons' figures is extremely difficult, there was no evidence in the groups of cases investigated to show that early weight-bearing exerted any deleterious effects.

It is apparent from all reported results of fractured femoral necks that approximately one-third are failures or unsatisfactory. 10% of these are accounted for by avascular necrosis. Only a small percentage are due to the complications of old age. The majority of the complications are due to bad pinning. It should be emphasized that the figures given are from a mixed group of surgeons, and that an individual surgeon, taking special care, can achieve considerably better results. The ideal position for the pin, as far as weight-bearing is concerned, corresponds to that worked out for other reasons, namely a longish pin lying low in the femoral neck and tangentially to the calcar femorale.

The greatest hope of improved results lies in the improvement in surgical technique. The use of cancellous grafts in association with the pin in some fractures might well be revived again. For cases with arthritic hips and irreducible fractures an immediate Judet operation may become the method of choice.

SUBCAPITAL FRACTURES

	All ages			Cases under 60 excluded.
	H. B. Boyd and I. L. George (1948)	R. T. McElvenny (1949)	A. L. Eyre-Brook and K. H. Pridie (1942)	Average age 72 Bonnin (1952)
Results	360 cases	65 cases	75 cases	40 cases
Mortality ..	7% in 4 weeks	Not given	5·3% in 3 months	7½% in 4 weeks
Union	85%	83%	70%	75%
Non-union ..	15%	17%	17%	17½%
Avascular-necrosis	..32·6% Union ..39·3% Non-union	4%	6·7%	7½%
Delayed union ..	—	8%	—	7½%
	No time of weight-bearing stated. Recommended 2–3 months in bed	No weight-bearing for 6 months.	Recommended 3 months in bed. 5 cases early weight-bearing	In bed 2–6 weeks. Average stay in hospital 7½ weeks

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Dr. J. B. Wyman, Westminster Hospital: *Anæsthesia.*—Anæsthesia in the aged is an everyday procedure. In 1951, the number of patients anæsthetized at Westminster Hospital over 70 years of age was more than four hundred. It was at once apparent that old people tolerated both anæsthesia and surgery extremely well and that no patient need be denied an operation on the basis of age alone. The general condition was far more important than the number of years they had survived. They do extremely well with the same drugs and the same methods as for other patients, and if all goes well they do not deviate from the normal post-operative course. Therein lies the key to the behaviour of the aged. If all is straightforward, the patient pursues an even course, but with the smallest error of judgment disaster threatens. A slightly obstructed airway will affect an aged myocardium in a

short time. The simple post-operative chest will, due to toxic and mechanical strain, throw a great burden upon an aged heart and incredibly quickly renal and liver failure complete the disastrous sequence.

Old people do not like to be divorced from their everyday surroundings and the sooner they are operated upon the better. In the preparation for operation morphia must be used sparingly and in small doses, as it produces profound respiratory depression which will affect the anæsthetic.

Atropine must be given as, in addition to its other functions, it will help to combat the respiratory depressant action of the morphia. Hyoscine or scopolamine should be avoided as "hyoscine mania" is a very real thing. Old people are sufficiently disorientated after an accident without the addition of this drug. Similarly, barbiturates excite these patients. Both scopolamine and barbiturates are sedatives but not analgesics and if given in the presence of pain are more likely to cause delirium than sedation (Goodman and Gillman).

Pentothal may be used for inducing anæsthesia and though there is nothing inherently dangerous in the drug itself its administration is fraught with danger. In old people the amount of Pentothal to be given must be greatly reduced. The more feeble and frail they are, the closer the anæsthetic dose approximates to the lethal dose and the margin of safety narrows considerably.

The aged require far less of any anæsthetic agent to achieve the required depth of anæsthesia. The choice of drug is not so important as knowledge and skill in its administration.

A clear airway is a *sine qua non* and old people will not tolerate even slight respiratory obstruction. Any attempt to relieve asphyxia, due say to spasm, by giving more Pentothal may be fatal. It is much safer to give a muscle relaxant and then administer oxygen.

Anæsthesia should not be regarded as merely a means of putting the patient to sleep for an operation but as a means of rendering expert resuscitation while that operation is in progress, and never is this great care more needed than when dealing with the aged.

Dr. C. J. Gavey, Physician, Westminster Hospital: *Medical aspects.*—The general condition or comprehensive mental and physical state of the aged is readily appraised even by an intelligent layman but it is exceedingly difficult to define. A good general condition is the opposite to "infirm", and it comprises an alertness and independence of mind in a body still resilient and neither wasted nor bloated. Indeed, too much medical investigation in these old people may lead to unwarranted delay in getting on with the job.

Blood pressure.—If an old person has survived thus far, hypertension can be discounted except in the uncommon instances where cardiac enlargement has occurred. This factor is often difficult to assess clinically and radiological assistance may be required. As a result of infection, which is the old man's chief enemy, a large heart will readily fail or will induce peripheral circulatory failure, and special care is required not to overload the circulation of such patients by too liberal transfusion. But despite occasional troublesome bleeding the average hypertensive old patient stands operation well; indeed, I think, often better than the patient with a blood pressure in the lower, though still normal, range. *Arteriosclerosis* is more likely to be dangerous in a normotensive subject, leading to thromboses, but advanced calcification is compatible with an adequate circulation. *Angina pectoris of effort* is extremely common in old people and, as Sheldon (1948) said in his Wolverhampton survey, they often do not report it, either because they do not suffer much or because they regard this restriction as normal or at least expected in old age. Pronounced angina of recent origin, and certainly a recent coronary thrombosis, calls for very conservative surgical treatment but after a month of satisfactory cardiac progress a necessary operation may be comparatively safe. One's insistence that all patients over 40 requiring major surgery should have a pre-operative electrocardiogram does not apply so imperatively in the old unless there is a history of angina or of dyspnœa. Sometimes an unsuspected auricular fibrillation is revealed by an electrocardiogram yet the heart-rate is not much, if at all, raised in the aged and a moderate dose of digitalis will control this unless infection supervenes. Heart block proper is always a serious complication but bundle branch block does not, in itself, preclude operation. Though the usual criteria of normality remain applicable to the electrocardiogram of the old we do not deny operation unless departure from normal is gross, and even then major surgery may be practicable.

Post-operative chest complications are still to be feared despite antibiotics. It is therefore especially reassuring when old persons deny bronchitis or even cough for they are far less prone to lung collapse or bronchopneumonia than the bronchitic, however mild. Unheralded pulmonary emboli are a common cause of chest symptoms and signs. Anticoagulants carry their own risk due to the danger of senile purpura. They find a place when the heart is unsound because pulmonary emboli are powerful cardiac decompensators.

The *central nervous system* in old people is often subject to faulty integration and slow reaction time. Sudden tumbles are well known to the surgeons, who have to repair their effects; yet nothing abnormal may be found on the minutest examination.

The ease with which damaged tissues may repair, even in advanced age, reminds us that ageing is a

physiological process of involution and gradual atrophy, not degeneration; hence attention to the general nutrition of the patient may be amply repaid. Old people may be in a state of malnutrition, though by no means wasted, because of an inadequate diet lacking in essential proteins and vitamins. Casilan, proteolysed liver and vitamin capsules B.P.C. may be given for three to four weeks after a fracture. Tuberculosis, diabetes, hypothyroidism and anæmia are readily overlooked. Fortunately all these can now be controlled. If there is much osteoporosis of endocrine origin stilbœstrol may be helpful.

Thanks to excellent anæsthesia the risk to-day has shifted from the operation to the post-operative period when shock, cardiac failure, sepsis and emboli still take their toll. Nevertheless the correct attitude towards the aged sick requiring surgical intervention should be one of cautious optimism.

REFERENCE

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Mr. O. J. Vaughan-Jackson first expressed agreement with Mr. Mervyn Evans' conclusions in the matter of trochanteric fractures. On the question of cervical and sub-capital fractures of the femur he expressed regret that more had not been said of the use of the Judet prosthesis in fresh cases of these fractures, and expressed the view that our limited experience so far, in using these prostheses in such cases, seemed to show that the principle of substitution of an inert artificial head for the fractured, and too often wholly or partly dead, head, looked like being acceptable in the *really* aged, that is to say, the eighties, eighty-fives and nineties. In these cases he suggested that their remaining years on earth were too short for them to spend months and even years, waiting to see (*a*) whether they had achieved union of the fracture, and (*b*) whether union was followed by good function. In a large number of cases in this age group, the patients were too feeble in any case to make use of the necessary aids to non-weight-bearing, and if their fractures were pinned, would be condemned to bed or a chair for many months.

The younger cases that had come under review, namely the 60-year olds, and 70-year olds, he contended should still have their cervical fractures pinned, for if the result was unsatisfactory, they still had reasonable time in which to have a Judet arthroplasty carried out. This would remain the method of choice until further prolonged experience of the Judet prosthesis showed that it was capable of supplanting the Smith-Petersen pin in all cases.

Mr. Vaughan-Jackson finally expressed the view that while the Judet prosthesis is quite satisfactory mechanically in cases of osteo-arthritis of the hip where the neck is intact, it is probably not in its present form the ideal prosthesis for use in fresh fractures where the cancellous and cortical structure of the neck is to a great extent disintegrated, and that therefore further experimentation with modifications is desirable.

In support of his contentions, he quoted briefly the results of an analysis of 19 cases of fractured femoral neck treated with the Judet prosthesis.

Mr. K. I. Nissen, referring to the immediate treatment of sub-capital fractures in aged patients, said that his experience with the Judet prosthesis had been rather uneven. Frequently the fracture was comminuted to some degree, with a considerable area of the posterior cortex of the neck missing and fissures extending into the region of the calcar femorale. Sometimes the remainder of the neck was almost hollow. For these reasons a firm seating of the prosthesis might be difficult to obtain, even when it was inserted in a valgus position. In one patient the prosthesis had gradually become almost horizontal and in two others the radiographs suggested that the track for the stem had become greatly widened. Crutches used for some months after operation might help to avoid such trouble.

Mr. F. G. St. Clair Strange felt that, in old people, more emphasis should be placed upon the value of treating comminuted fractures of the extremities of the humerus (involving the shoulder and elbow joints) by functional methods. He supported Mr. Grant Bonnin's view that delay in reduction in sub-capital fractures of the neck of the femur might have some bearing on the incidence of avascular necrosis. He himself had been attempting to obtain early reduction in these cases.

Section of Surgery

President—Professor F. A. R. Stammers, C.B.E., T.D., Ch.M., F.R.C.S.

[*October* 28, 1952]

Acute Pancreatitis

By Laurence S. Fallis, M.D.
Henry Ford Hospital, Detroit

At the Henry Ford Hospital our current interest in the subject is exemplified by the relatively large number of cases of acute pancreatitis available for this study. The acceptance of the value of the serum amylase test as evidence of acute pancreatitis has resulted in the recognition and recording of numerous instances of the disease in which not all of the classical symptoms presented. The pathologic picture varies all the way from simple œdema of the pancreas or necrosis of a lobe or isolated area in one or other of the anatomic divisions to complete disruption of the gland. In general, the symptoms reflect the degree of pathologic involvement, an observation that explains why a considerable number of patients who actually suffer from the milder degrees of acute pancreatitis remain undiagnosed. Of the 250 cases included in this study the diagnosis was verified by subsequent laparotomy or autopsy in 58%, but only about one-fourth could be categorized as being in the acute pancreatic necrosis group. The recognition of any appreciable number of this disease is attained only when the staff in the Emergency Department attach as much importance to the value of a serum amylase estimation as they do to a white blood and differential count.

The ætiology of acute pancreatitis is still a matter of conjecture in spite of the many theories that have been promulgated. It is certain that back pressure in the pancreatic duct plays an important role, whether it is secondary to obstruction of the bile papilla, the so-called common channel theory, or primary from blockage of the duct of Wirsung by calculus or metaplasia of the ductal epithelium as suggested by Rich and Duff. In a limited experience with recurring pancreatitis we have been impressed with the importance of cicatricial contraction of the bile papilla in these cases. Since obstruction cannot be demonstrated in many patients with acute pancreatitis it is probable that there are many ætiological factors. The role of alcohol in the production of acute pancreatitis is well known. It may be that excessive alcoholic intake induces a duodenitis and that the resultant œdema of the bile papilla produces obstruction of the pancreatic ductal system. In our experience it is the combination of food and alcohol that appears to initiate the attack. The consumption of numerous cocktails followed by a large meal often provokes an attack, the classic example of which is the city father, stricken at the mayor's banquet.

The outstanding clinical feature of the disease is the severity of the pain. Patients often volunteer the information that the pain was so severe that a second injection of a 1/4 grain of morphine had to be given to obtain relief. The intensity of pain is most pronounced in the mid-epigastrium and often it is transmitted to the back. Characteristic of the disease is the desire of the patient to sit up in bed and lean forward. Nausea and vomiting persisting during the early phase of the disease occur in 90% of the patients. Shock and cyanosis except in the fulminating cases of acute pancreatic necrosis are rare. In fact, absence of shock is a noteworthy feature of the average case of acute pancreatitis because it is so much at variance with the classic concept of the disease. The objective abdominal signs are in inverse ratio to the apparent severity of the attack. The moderate upper abdominal distension and minimal spasm of the rectus muscle are in marked contrast to the pronounced spasm found in acute cholecystitis. Fully 25% of the patients show clinical evidence of jaundice some time during the attack. This jaundice is not entirely confined to those patients showing evidence of common duct obstruction for it also serves to emphasize the extreme toxicity which occurs in this disease with its resultant effect on the parenchymal cells of the liver. Discoloration of the skin in the flank, Grey Turner's sign, or around the umbilicus, Cullen's sign, is present in from 2 to 5% of patients. A good light and repeated careful examinations may be necessary to detect this manifestation. Unfortunately, this sign appears late in the disease and is of little value in differential diagnosis at a time when decision has to be made. Its presence is therefore only of confirmatory value.

The finding of an elevated serum diastase level is the sheet anchor in the diagnosis of acute pancreatitis. There are certain pitfalls to be avoided; for example, the patient may be seen early in the disease before the amylase level has risen. This is especially true if the patient is investigated during the first twenty-four hours of the attack. It is therefore essential that repeated estimations should be made. Moreover, the amylase level may have returned to normal in a patient seen late in the course of the condition. Also, in the very acute cases or fulminating cases in which the entire pancreas is destroyed there may be no increase in the amylase level. False positive findings occur in perforated or penetrating peptic ulcer and in certain liver and kidney conditions. However, when the elevated diastase level confirms the clinical impression one can be reasonably certain that the patient is suffering from acute pancreatitis.

The polymorphonuclear response is usually prompt and is clear indication of the destruction of pancreatic tissue. In this group of patients the average white blood count was 13,000 per c.mm. and the average polymorphonuclear count was 88·6%. Elevated blood-sugar levels were observed in 44·6% of the 130 patients on whom this test was run. In many instances the disturbance is simply that of decreased dextrose tolerance, in others a transitory diabetes develops, and in others again true diabetes requiring insulin is produced. Diabetes is a serious complication of acute pancreatitis, therefore prompt recognition and adequate treatment for its control are necessary. It is well established that in a true diabetic with acute pancreatitis, the prognosis is grave indeed. Blood-calcium levels are lowered in the more serious cases and this decrease is due to the mobilization of circulating calcium for deposition as the characteristic plaques of fat necrosis. The pronounced lowering of the blood-calcium level is of serious prognostic import since recovery is rare when an estimation below 7 mg.% is obtained.

In the differential diagnosis acute cholecystitis, the disease with which acute pancreatitis is most often confused, must be ruled out. Here we find that the muscle spasm is more pronounced, the pain is less severe and more readily yields to sedation. Perforated peptic ulcer can usually be ruled out by means of the scout X-ray film which should always be taken to exclude the presence of free air and to demonstrate the positive finding which sometimes occurs in acute pancreatitis; namely, dilatation of an isolated loop of proximal jejunum. In the more serious cases cyanosis, lowered blood pressure and rapid pulse may suggest coronary thrombosis. It is, therefore, advisable to have an ECG examination made on these patients. As a rule, the diagnosis is overlooked in most cases in which the possibility of acute pancreatitis has not received adequate consideration.

Management

Up until 1935 all the patients in this series on whom the diagnosis was made were treated by immediate operation with a mortality rate of 46%. Since that date all patients have been treated by conservative or non-operative measures with a mortality rate of just under 7%. The great problem in conservative management of acute pancreatitis is, of course, the diagnosis. When the decision not to operate is made upon a patient constant supervision with repeated examination of the abdomen is mandatory in order that the plan of treatment may be altered to meet changing conditions and that the diagnosis may be revised. The excruciating pain of acute pancreatitis requires full and repeated doses of demerol (pethidine), a synthetic compound which is just as efficacious as morphine and without the danger of producing spasm of the sphincter Oddi. Vomiting and distension are relieved by a continuous gastric suction. Introduction of the nasal tube into the stomach relieves vomiting and distension so effectively that patients often volunteer the information that the stomach aspiration gives them as much relief from the pain as does the narcotic injection.

Fluid and blood levels are maintained as indicated by the patient's condition. Blood-sugar estimations should be made at intervals and treatment of the hypoglycæmia carried out when indicated. Repeated estimations of the blood diastase should be made though the amount of elevation does not necessarily gauge the severity of the disease, since the test may early return to normal in a patient with complete destruction of the gland. Antibiotics are indicated because infection as an ætiologic factor cannot be entirely ruled out and their use may prevent the development of complications. Banthine, a drug that inhibits the vagus nerve, is given with the objective of cutting down the amount of pancreatic secretion. Under a regimen such as the foregoing, in the average patient the adverse symptoms tend to abate and evidence of subsidence appears after the fifth day. We have not had experience with either the paravertebral block or epidural anæsthesia because we have found that full sedation plus continuous gastric suction relieves the pain in most instances. Common complications of acute attack are hepatitis, as evidenced by jaundice, hyperglycæmia, dilatation of the stomach, intestinal ileus and pleural effusion. All these conditions should be watched for and treated if and when they arise.

Careful appraisal of the abdomen should be made during convalescence to detect the development of pseudocyst, abscess formation, &c. In this series a total of 28 patients subsequently had diabetes requiring treatment. Of this number 16 were known diabetics before the attack, 7 developed during the attack and 5 subsequently. Repeated exacerbations of acute disease during hospital stay are not infrequently observed and a definite proportion of patients will go on to develop chronic recurring

pancreatitis. When the convalescence is complete investigation of the biliary tract is indicated since 75% of these patients have co-existent biliary tract disease. Definitive biliary tract surgery should be carried out when indicated. Removal of the gall-bladder does not protect the patient entirely from subsequent difficulty since attacks of acute pancreatitis have been observed in patients whose gall-bladders had been removed.

SUMMARY

In summary, it may be said that (1) acute pancreatitis is a commoner disease than is usually supposed; (2) there are many phases of the disease other than the classical acute pancreatic necrosis; (3) diagnosis is frequently overlooked because acute pancreatitis is not considered in the differential diagnosis of obscure abdominal conditions; (4) the outstanding diagnostic features of the disease are the severity of the pain and the elevated serum amylase; (5) conservative or non-operative treatment gives the best results; (6) when the attack has subsided investigation of the biliary tract should be done and definitive surgery carried out when indicated.

[*November* 5, 1952]

DISCUSSION ON RECONSTRUCTIVE ARTERIAL SURGERY

Mr. R. C. Brock: The subject under consideration clearly covers a large field and I shall deal with only the more modern developments, particularly the important techniques of resection and insertion of a homograft. I shall deal chiefly with the aorta and shall say nothing of the larger peripheral arteries.

The contributions of Rudolf Matas to the various forms of direct reconstructive arterial surgery are now classic. During the last few years, however, more ambitious attempts have been made at reconstructive surgery of the aorta for aneurysm, culminating in the recent splendid work of Bahnsen of Baltimore and Cooley and De Bakey of Houston.

Alexander and Byron (1944) were the first to resect an aneurysm of the thoracic aorta; this occurred in association with an aortic coarctation in a young student. Unfortunately they were unable to bridge the resultant gap and had to be content with simple closure of the ends of the aorta. There was thus no reconstruction and it is not surprising that the patient later succumbed to the hypertensive features of his disease. Monod and Meyer in 1950 were more successful in the case of a young woman aged 20 who had a saccular aneurysm of the aortic arch; they were able to remove it and to control the neck of the sac by simple suture, thus restoring a normal aortic lumen.

In this Society and before this Section, at the recent Halsted Memorial Celebrations, Alfred Blalock described 4 dramatic cases operated on by his junior colleague, Henry Bahnsen, who was successful in excising the sac and reconstructing the aortic wall in 4 cases of syphilitic aneurysm. Cooley and De Bakey (1952) have recently described their own experiences in 6 cases of large saccular aneurysm of the aorta, in which they have employed a similar procedure. In none of these cases was the diseased aorta actually resected; continuity was not disturbed, the aneurysmal sac alone being removed.

Complete resection of a lesion of the aorta is only feasible if aortic continuity can be restored; otherwise the sinister effects of aortic obstruction ensue. In all but small, localized lesions, such as a simple aortic coarctation, resection results in a gap which cannot be closed by approximation of the aortic segments; some form of bridging of the gap is essential. The use of plastic tubes was reported on favourably by Hufnagel (1947) but few would champion the use of a non-animal prosthesis of this sort, now that success has been achieved by the use of aortic homografts. Indeed, the introduction of arterial grafting has completely revolutionized reconstructive arterial surgery and for this reason I shall deal entirely with this method.

In some smaller vessels venous autografts can be used with perhaps greater safety, confidence and success; but in dealing with reconstruction of the aorta, provision of a venous autograft scarcely seems practical.

ARTERIAL HOMOGRAFTING

Many of the basic facts of vessel grafting were worked out by a number of investigators in the early years of this century (*see* Deterling *et al.*, 1951); Alexis Carrel was able to record successes with homografts preserved by refrigeration in the years before the First World War. No more was, however, heard of this work until Gross of Boston and his associates (Gross *et al.*, 1949; Peirce *et al.*, 1949) revived the method and developed a technique of refrigeration that has proved very successful in both experimental and clinical practice. With this technique segments of the aorta or of other vessels are obtained aseptically within a few hours of death and are then stored in a nutrient solution at a temperature of 2°– 4° C. The most satisfactory nutrient-preserving solution appears to be a balanced

salt solution (B.S.S.) containing 10% homologous serum with small quantities of added antibiotics. By this method viable arterial segments may be preserved for periods up to seven or eight weeks and occasionally longer.

Following on the work of Gross, Swan and his associates (Swan *et al.*, 1950) and Deterling *et al.* (1951) have also published valuable contributions. Graham (1952) has recently reported on the experimental work at Guy's Hospital on the investigation of graft preservation by B.S.S.; Brunnen (1953) has just concluded a further series of experiments in which other methods of graft preservation have been investigated. These include formalin, sterilization by cathode-irradiation, and also deep freezing at −27° C. Eastcott (Hufnagel and Eastcott, 1952), writing from St. Mary's Hospital, has reported on the deep-freeze method.

The use of preserved homografts has now gone beyond the stage of trial to that of achievement. Considerable success has been attained in human surgery so that we can have great confidence in the method. It is true that we do not yet know the long-term results—the ultimate fate of these cases. Time will eventually correct this, and meanwhile we are encouraged to continue by the knowledge that the conditions we are treating by these methods would soon prove fatal without the operative interference now being accorded them. Even though unfavourable features should later arise, these patients will have gained much. While we await this longer follow-up, methods are being consolidated and expanded.

The *consolidation* of the technique comes from its wider and greater use in more centres throughout the country. There is an urgent need for the establishment of blood-vessel banks in all big surgical centres. The good results that can already be put forward should prove that this need is a pressing one. I would only add that, although the present methods are relatively simple and are fairly easily mastered, they deserve some care and respect. They demand the attention of someone who can devote an adequate time to their safe application and advancement.

The *expansion* of the technique comes from improvement of methods. The preservation of arterial segments in the balanced electrolyte solution at temperatures just above freezing point undoubtedly gives excellent results; probably slightly better results than are given by any other technique. The method is, however, wasteful in that the material cannot be stored with safety for much more than seven to eight weeks. The difficulty of obtaining a regular, steady supply of vessels for grafting means that by this wet method it is almost impossible to form and maintain a genuine vessel bank or store; this is a precarious position. Patients must often wait for operation until a recently preserved graft is available.

The advantages of a more permanent bank are many and obvious, and the greatest present need is to find the simplest and best methods for this purpose. Deep-freeze, either at −25° to −30° C., or at −70° C., seems just now to be the favourite. Certain chemical methods, such as formalin preservation, must be considered, and doubtless others will emerge. In addition we need to perfect the taking of the graft; in particular the means of achieving absolute sterility when it has not been possible to use full aseptic precautions. The present need for aseptic methods in collecting the graft greatly limits the ready supply of material for a bank. Everyone who is dealing with cardiovascular surgical problems should acquire an organization that will enable him to have ready to hand a supply of suitable vessel homografts which may be used for the techniques that I shall now describe. I think it is best to illustrate the present achievements by a simple description of 5 cases in which aortic resection with reconstruction by homografting has been successfully used. It is perhaps worthy of comment that these 5 representative cases have all been operated upon during the last twelve months.

Aortic Coarctation

The accepted treatment for this condition, introduced by Crafoord and by Gross, is excision of the strictured aortic segment and restoration of continuity by direct end-to-end suture. Happily the stricture is usually short and a simple reconstruction of the aorta can be achieved in this way in a high proportion of cases. Conditions are, however, met with in which satisfactory aortic reconstruction cannot be achieved by simple end-to-end suture. Blalock's method of turning down the left subclavian artery to complete the anastomosis in difficult cases is no real answer as the hypertension is usually not relieved.

The prime object of the operation is, by correcting the aortic obstruction, to convert the hypertension to a normal blood pressure and thus avoid the inevitable ill-effects. Unless this is achieved the operation fails. Success depends on replacing the narrowed segment by a wide, free lumen. It is usually stated that this lumen must be at least 60% of the normal aortic lumen. In many cases it is possible to achieve this if both aortic segments are freely mobilized so that they can be brought together without tension after a sufficiently wide resection of the strictured portion has been made. This is usually easy in young children, and becomes increasingly difficult in older patients when the disproportion may be greater and the ends more difficult to mobilize.

Additional local factors may make a wide resection necessary; so wide that reconstruction of the aorta by direct suture is impossible. Without a graft the only course is to abandon the operation

without removing the obstruction; or if the resection has already been done, to close the two aortic ends. Such local factors have been outlined by Gross (1951) as:

(*a*) a very long segment of narrowing;
(*b*) rigid inelastic aorta even if the gap is narrow;
(*c*) aneurysm of the aorta or of intercostal arteries;
(*d*) surgical injury to the aorta or its major branches.

It is a serious matter to have to close the chest in a case of aortic coarctation without giving the patient relief. It is also unsatisfactory if, because of local conditions, an imperfect resection and suture is made so that the obstruction is only partly relieved and the hypertension only incompletely corrected.

The use of a homograft improves the chances of success enormously. My own feeling is that it is not justifiable to operate on a patient in the late teens or older, who has an aortic coarctation, unless a homograft is available. Some two years ago I operated on a young woman with hypertension who was eager to be cured so that she could marry and have children. I did what I thought was an adequate resection with a good anastomosis although the final lumen was not full-sized; if I had cut back far enough to achieve a full-sized lumen the gap would have been too big for closure. She has not been relieved of her symptoms, nor is her blood pressure any lower: the operation has failed. Slight tension on the anastomosis probably caused further narrowing and a poor result.

Cases I and II.—During the last year I have operated upon two young adults in whom restoration of a full lumen without any tension could be achieved only by insertion of a homograft. In one of these the aorta had a second minor constriction above the main one with an aneurysmal dilatation between; even after free mobilization a gap of some 2·5 cm. remained. In the other the first pair of intercostal arteries arose in such a way that they had to be resected with the stenosis and again a 2·5 cm. gap resulted.

Both of these patients had a satisfactory reconstruction of the aorta by a homograft and this has been reflected in excellent clinical results with complete conversion of the hypertension.

Gross (1951) has reported 19 cases in which he used a homograft out of 120 cases of aortic coarctation; in 3 of these the graft had been frozen, in the other it was preserved in B.S.S. 2 deaths occurred, both from incompatible blood transfusion, the grafts being healthy. The results were excellent in 14, satisfactory in 1, fair in 1 and unsatisfactory in 1 in whom thrombosis seems to have occurred after seven months. I understand that Gross has now used a graft in some 45 cases.

Aneurysm with Coarctation

Mention was made earlier of Alexander and Byron's case of aneurysm associated with coarctation in which after resection the ends had to be closed because the gap could not be bridged. This condition of a large aortic aneurysm together with a coarctation is occasionally seen, and I have described elsewhere (Brock and Graham, 1952) a case which I was able to treat successfully by resection and insertion of a homograft 5 in. (12·5 cm.) in length. Swan *et al.* (1950) have also described an example.

Case III.—R. G., a man aged 28, had an illness due to bacterial endocarditis and which was recognized to be associated with an aortic coarctation. The classical signs of coarctation were present and he had a hypertension of 240/120 mm.Hg. While under penicillin treatment he suffered a subarachnoid hæmorrhage. A chest radiograph showed a calcified opacity low in the posterior mediastinum, the significance of which was not appreciated at the time.

At thoracotomy in November 1948 there was no coarctation at the usual site but a large calcified aortic aneurysm was found about 5 cm. above the diaphragm; below it was a coarctation. As resection would have involved closing a long gap and as no graft was available, the operation was abandoned.

Owing to many difficulties, a longer time than was desirable elapsed before it was possible to provide safe grafting material, checked by laboratory experimentation. It was not till October 1951 that a suitable homograft was obtained and the patient was readmitted.

He was now aged 31 and his condition had slowly deteriorated; for one year he had been unable to work. His blood pressure was 240/160 mm.Hg and the aneurysm was slightly larger. Clearly his future was very black with an aneurysm proximal to a coarctation and exposed to a pressure of 240 mm.Hg.

A second operation was performed on November 1, 1951, just one year ago. The aneurysm was resected together with the coarctation and the long gap closed with a graft measuring 12·5 cm. (5 in.) in length (Fig. 1).

Fig. 1.—Photograph of aortic homograft, 12·5 cm. long, inserted in Case III, after resection of combined aneurysm and coarctation.

He made a good recovery from the operation and is now back at work, free from all symptoms. He has excellent and normal pulses in his lower limbs and the blood pressure is 130/80 mm.Hg. The threat to his life from rupture of the aneurysm, from another subarachnoid hæmorrhage, from recurrence of bacterial endocarditis or from hypertensive cardiac failure seems to have been removed.

Aneurysm

From aneurysm associated with coarctation we proceed to aneurysm without obstruction. In the presence of an obstruction a collateral circulation develops which allows safe clamping of the aorta for resection and grafting. This is especially important in the thoracic aorta when prolonged occlusion carries the risk of damage to the spinal cord. This happened in the case reported by Lam and Aram (1951) in which a syphilitic aneurysm of the thoracic aorta was resected and a homograft 14 cm. long inserted; an attempt was made to avoid spinal cord damage by using a polythene tube while the graft was being sutured. Unluckily the patient died three months later from suppuration within the sac which had been incompletely removed. In spite of this late death Lam and Aram's case is a notable achievement.

Resection of the abdominal aorta for aneurysm does not carry the same danger of damage to the spinal cord, although many other technical difficulties arise, notably the danger to important aortic branches such as the renal arteries. I am able to report a case of successful resection of a huge aneurysm of the abdominal aorta with restoration of continuity by insertion of a homograft extending from just below the renal arteries to the beginning of the two common iliac arteries, i.e. including the aortic bifurcation.

Case IV.—Mrs. M. S., aged 50, first noticed a pulsating swelling in her abdomen in 1948; it had steadily increased in size. It was not painful, but since an aortogram in 1951 she had had cramp-like pains in the left foot and a dull ache in the left thigh and burning in the left buttock. There was no intermittent claudication and all vessels in the lower limbs pulsated normally. Her blood pressure was 130/90 mm.Hg. The Wassermann reaction was negative. There was no sign of arterial disease elsewhere in the body. At the request of Mr. Brian Truscott of Cambridge, Professor A. Kekwick at the Middlesex Hospital performed an aortogram in September 1951. This showed a large fuso-saccular aneurysm occupying much of the abdominal aorta which was kinked sharply to the left as it entered the sac. It was not possible to define the relationship of the aneurysm to the renal arteries; indeed from the upward extent of the aneurysm it seemed inevitable that they should be included in it. The urine was normal.

Mr. Truscott kindly asked me to see the patient in October 1951 and at that time I decided against operation owing to the probable involvement of the renal arteries and because of lack of experience in the reconstructive surgery of this region. However, owing to our experiences during 1952 I felt that resection should be attempted and that the aneurysm almost certainly did *not* involve the renal arteries in spite of the appearances. In October 1952 the aneurysm was much bigger and extended from the costal margin almost to the pubes; it was peculiarly mobile as if on a short pedicle. The aortogram was repeated in an attempt to define the distal anatomical connexions, but, in spite of two injections of Diodone, the aneurysm would not opacify although near-by small branches were well shown. Presumably it was now so large that the contrast medium was too diluted.

Operation was performed on October 25, 1952, the abdomen being first opened by a mid-line incision almost from pubes to xiphisternum. The huge, partly pedunculated, aneurysm filled much of the operative field like a gravid uterus or large ovarian cyst (Fig. 2). Below, it involved the bifurcation, and the two common iliac arteries emerged from its antero-inferior surface. Above, it reached to the costal margin and its mass made it impossible to assess its upper connexions. It measured 20 cm. in length, 12 cm. in width and 11·5 cm. in depth.

Fig. 2.—The huge abdominal aneurysm in Case IV.

The incision was extended along the line of the 9th rib as far as the posterior axillary line; the costal margin was cut through and the diaphragm divided so as to give a free exposure of the whole of the left subphrenic region. The peritoneum was now divided in the left paracolic gutter, beginning at the pelvic brim and extending up past the spleen to the œsophageal hiatus; spleen, stomach, colon, duodenum, pancreas and the root of the mesentery of the small gut were all dissected free and displaced to the right so as to expose the whole length

of the aneurysm, the aorta above it, and the inferior vena cava. Only after this had been done was it possible to define the upward extent of the aneurysm. This was fortunately found to be about 3 cm. below the renal arteries. A short length of somewhat thin, but otherwise healthy, aorta lay between the renal arteries and the aneurysm. This portion was turned 90 degrees upwards and to the left and was so pressed upon by the huge aneurysmal sac in front that it was considerably obstructed. Displacement of the aneurysm with the hand increased the pulse in this part of the aorta.

The inferior vena cava was so closely applied and adherent to the sac that caval obstruction or intracaval rupture seemed to be a likely early complication.

The whole aneurysm was eventually freed and excised; continuity was restored by insertion of a homograft measuring 10 cm. and consisting of the lower part of the abdominal aorta and its bifurcation. The upper suture line lay close to the renal arteries; below, each common iliac artery was joined to the stumps of the iliac branches of the graft (Fig. 3). The graft filled and pulsated well. Although it is still early days, the patient's condition

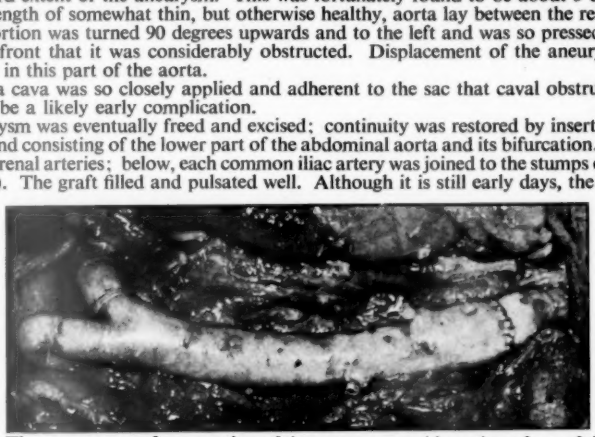

FIG. 3.—The appearance after resection of the aneurysm and insertion of a graft involving the aortic bifurcation in Case IV.

is perfectly satisfactory and excellent pulses can be felt in the lower limbs, the nutrition of which remains quite normal.

The homograft used was nineteen days old and had been preserved in B.S.S. In 1952 Dubost successfully operated on a similar case by resection and insertion of a homograft (Dubost *et al.*, 1952).

LERICHE'S SYNDROME OF INSIDIOUS THROMBOSIS OF THE AORTIC BIFURCATION

In 1940 René Leriche described a peculiar and typical syndrome related to thrombotic obliteration of the end of the abdominal aorta. A more recent account has been given by Leriche and Morel (1948) in which 4 cases are described. They state the syndrome has no relation to "saddle embolism", so long known, but "appears to be a disease with a long course presenting, for a long period, symptoms which may have no meaning to the physicians, unpleasant as they may be for the patient". From the scarcity of reports in the literature, it might be assumed to be rare, but now that it has been recognized a fair number of cases are appearing. The article by Leriche and Morel should be consulted for fuller information on the clinical and other features. Aortic thrombosis, although apparently well borne for years, always ends in gangrene.

Leriche recommended removal of the thrombosed portion of the aorta and its bifurcation together with bilateral sympathectomy. It is, however, clear that the ideal treatment for the condition is resection of the thrombosed segment and reconstruction of the aorta and its bifurcation by insertion of a homograft.

I shall describe a case in which I have been able to do such an operation with success.

Case V.—Miss I. E., aged 44, was admitted to Guy's Hospital in May 1952 under the care of Dr. A. H. Douthwaite complaining of severe pains in the hips and thighs occurring chiefly with exercise, and preventing her walking more than a very short distance. About three years earlier she noticed pain in the right calf on walking; about six months after this she began to get pain in the region of the right hip, buttock and thigh of a cramplike nature. During the six months before her admission she had had pain in the left calf, buttock and thigh, much more severe than on the right. Her disability was such that she could walk only 30 yards; pain was relieved after two to three minutes' rest. Since December 1951 she had noticed coldness of the feet.

The blood pressure in the arms was 180/115 mm.Hg. The fundi were normal; apart from a short apical systolic murmur the heart was normal. There were no trophic changes in the skin of the lower limbs but no pulsation could be felt in any vessel below the level of the umbilicus, at which level the aortic pulsation ceased. The blood pressure varied from 210/180–120/105.

An aortogram showed complete obstruction of the aorta beginning apparently at the level of the inferior mesenteric artery and extending to the bifurcation of the common iliac arteries. The Wassermann and Kahn reactions were negative. The urine contained a trace of albumin on one occasion; blood urea was 34 mg.%. Intravenous pyelogram was normal.

Dr. Douthwaite kindly referred the patient to me.

Operation was done on June 26, 1952, through a mid-line incision extending from the pubes to midway between the umbilicus and ensiform cartilage. The intestines were packed away and the aorta and two common iliacs approached directly by incising the peritoneum over them.

Both common iliac arteries were obviously solid with clot extending down to their bifurcation. The aorta felt solid right up to where it was crossed by the left renal vein. Moreover the aortic wall showed shallow external deformities strongly suggesting atheromatous changes. It was rigid and partly calcified. The inferior mesenteric artery was very small at its origin and was obviously thrombosed at this site.

The external and internal iliac arteries were defined on both sides and controlled by bulldog clips. Each common iliac artery was then incised about 1 cm. above its bifurcation and the distal ends of the thrombus gently teased out of the two branches. This enabled a single distal anastomosis to be used on each side.

The first section of the aorta was made about 3 cm. above the bifurcation but the vessel was found to be completely occluded with organizing clot: about 2 cm. was teased out from above but no blood flowed. A further 1 cm. of aorta was resected but still no bleeding occurred when the aortic clamp was removed. It was obvious that the thrombus extended up to the level of the renal arteries. Organized clot was removed until finally a good flow of blood was obtained. Further large organizing thrombi were expelled by the rush of blood.

The condition of the aortic stump was very unsatisfactory; the intima, which in any case was irregularly thickened and ulcerated, had been lacerated in several places and so a further 1 cm. of aortic wall was removed until reasonably good material for suture was obtained, but even at this level (just below the renal arteries), the wall was sclerotic, partly calcified and obviously bad material for suture. The specimen is shown in Fig. 4.

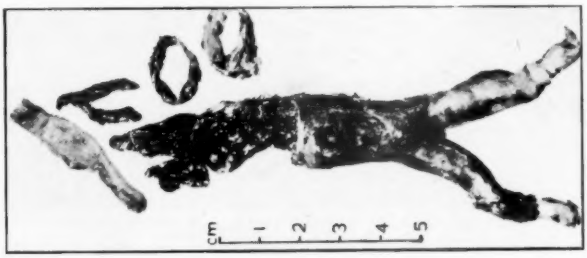

FIG. 4.—The specimen of thrombosed aortic bifurcation and common iliac arteries excised in Case V; a homograft of the aortic bifurcation was inserted.

The gap was filled with a homograft (preserved in B.S.S.) 9·5 cm. long; it was under rather more tension than seemed desirable. Suturing was very difficult owing to the atheromatous condition of the host's aorta and iliac arteries. All, however, went well and a good flow of blood occurred through the graft.

The patient made a good recovery apart from some œdema of the right leg which came on four days after operation. This was not surprising considering the common iliac veins had been firmly adherent to the thrombosed vessels. Heparin therapy was begun on July 1. Excellent femoral and peripheral pulses were felt from the beginning.

An aortogram was repeated just before her discharge from hospital and this shows the graft is functioning perfectly. Unfortunately, a small saccular aneurysm is shown at the level of the anastomosis between the graft and the left common iliac artery.

When she was last seen, one month ago, the feet and legs were warm and the peripheral and femoral pulses were good. She could walk 1 mile quite normally and had lost all her pre-operative pains. Her blood pressure was 210/140. In view of this established hypertension it was decided, at any rate for the present, not to do anything about the left iliac aneurysm.

It was not till after I had done this operation that I discovered that Oudot (1951) had already successfully operated on 2 similar cases by excision and insertion of a homograft. In his first case, a woman aged 51, the right common iliac artery thrombosed and needed insertion of a new graft between the iliac vessels on each side. His second patient was a man aged 52.

Comment.—These cases are long, anxious, tiring, one might even say exhausting, cases. I happen to be the actual surgeon, but I wish to point out that much pre-operative work was needed, quite apart from the hard and unstinted efforts of my assistants and colleagues during the operation and in the post-operative period. I would like to express my gratitude to them for their help and to emphasize that success demands this loyal co-operation.

I hope that, by the presentation of these 5 cases, I have proved my contention that much has been achieved in aortic resection and reconstruction by homografting, that the time has come for others to make use of the method, and that the future will bring further important developments.

It might be said that this is a very highly specialized and somewhat unprofitable form of surgery, considering the expenditure of energy and time involved. I am sure that this is not so, because apart from the advance of pure surgical methods, there is the important question of the application of reconstructive arterial surgery to gunshot wounds and other injuries of large vessels. If another war should descend upon us, there can be little doubt that there would be many patients available to receive benefit from blood-vessel grafting.

In such circumstances the existence of a blood-vessel bank organization would be invaluable and there can be no doubt that now is the time to start such an organization. This reason alone justifies and indeed calls for keen interest in reconstructive surgery and in homografting in all large surgical centres. The provision of a well-organized blood-vessel service is as necessary in its own way as the existence of a blood-tranfusion supply service. It still remains necessary even though venous autografts are so much more convenient for use in cases of injury to peripheral arteries.

One of the barriers to the formation of a large enough bank is the difficulty of obtaining a sufficient supply of material. In part this is due to prejudice although it is noteworthy that this prejudice rapidly fades before the impelling argument of living good results from successful aortic and other vessel grafting. In part also it is due to the legal problems involved. Indeed, I suppose that our present methods of obtaining material are of doubtful legality.

With the present achievements of blood-vessel grafting, scanty though they may be, and with the immensely important civil and military requirements mentioned, this position of doubtful legality and of hindrance to progress is unsatisfactory. The time has come when we should press for legislation to cover the needs of this service so important to humanity. The pressure of the evidence in its favour is as yet not large but it is there, significant enough in all its aspects, for the wise man to see and grasp. A great step forward was made when the recent legislation was passed so smoothly, sanctioning and encouraging the taking of corneæ for grafting in the relief of blindness. Parliament should grant similar facilities to enable blood-vessel banks to be organized and maintained so that this country should not be lacking in peace nor unprepared in case of war.

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Professor C. G. Rob: Mr. Brock has discussed the reconstructive surgery of the aorta and the common iliac arteries. I wish to concentrate on the arteries of the lower limb and in particular the treatment of senile obliterative arterial disease by artery grafting.

The anatomy of intermittent claudication and gangrene of the toes has been investigated by Boyd *et al.* (1949); he has shown that a high proportion of patients with either of these symptoms have a localized thrombus in a main vessel of the limb, and in my opinion two-thirds of these patients have a lesion in their artery which is anatomically suitable for an artery graft. The fact that senile obliterative arterial disease is a general process must never be lost sight of, the intermittent claudication or gangrene being purely a local manifestation, and the results of any local treatment will be governed by the general disease. For example, it is obviously a waste of time to graft a patient who gets intermittent claudication at 100 yards for him to be stopped after a successful operation by the worse pain of angina pectoris at 150 yards. There is also the ever-present risk of both coronary and cerebrovascular accidents in these patients. In practice this means that although 66% of these patients are anatomically suitable for an artery graft, only 20% or less will be benefited by such an operation.

The majority of patients with intermittent claudication or gangrene of the toes have a block in the superficial femoral or popliteal arteries, usually just at the point where the artery passes through the tendon of the adductor magnus muscle. Figs. 1 and 2 illustrate such a case and the post-operative result after insertion of an artery graft.

For efficient artery grafting it is essential to have an artery bank. Eastcott of St. Mary's Hospital with Hufnagel of Washington (1950, 1952) have developed a technique for the preservation of arteries by rapid freezing. This method is based on the well-known principles of food preservation and has the advantage that vessels can be stored for an indefinite period. We have used them after nine months but would be prepared to use them after several years. In brief, the technique consists in removing the arteries from a suitable donor who must have died within six hours and not have been suffering from a transmittable disease. In addition his arteries must have been macroscopically normal. The arteries are removed with full aseptic precautions as in a surgical operation and then placed in isotonic saline. The freezing is carried out in sterile pyrex tubes. The tube is then put into a freezing mixture consisting of alcohol and CO_2 snow which has a temperature of $-79°$ C. and it is left there for five minutes. After this the tube is transferred to the artery bank which is run at a temperature of $-70°$ C. or less. This is achieved by having a deep-freeze in which is a container of

CO_2 snow, the CO_2 snow being renewed every third day; this operation is the only maintenance required. The first frozen human artery bank to be installed anywhere in the world is at St. Mary's Hospital, London.

An alternative to artery grafting is vein grafting. This has many advantages: a bank is not necessary and the vein is autogenous and not homologous; but, in our opinion, artery grafts have certain advantages over vein grafts. They are preferable for the major vessels—the aorta and its large branches—and they are easier to use if the host vessels are arteriosclerotic. It is difficult to insert a vein graft into a patient whose vessels are arteriosclerotic and much easier to insert an artery graft. Whilst with improvement in our technique it is probable that we shall use more and more vein grafts in these patients, at the moment we reserve them for patients with relatively normal vessels. The battle casualty with a wound of a peripheral blood vessel is an obvious example. In this connexion the work of Lieut. Janke of the Medical Service Graduate School, Walter Reed Hospital, Washington, U.S.A., is of interest. He has organized a school of vascular surgery in Korea where field surgeons are trained to do vascular anastomoses on dogs. As a result of this 40 battle casualties in Korea with wounds of vessels such as the femoral and popliteal have been treated with immediate vein grafts from their own saphenous vein. The results have been excellent, 35 of them remaining patent. No heparin was used. A great achievement! Figs. 3 and 4 show a patient before and after a vein graft for arteriosclerosis and it will be seen that there is some ballooning of the graft. It is desirable but difficult to put these grafts in under tension and it is important to remember that they should be put in upside down, otherwise the valves will obstruct the flow of blood.

FIG. 1.—Thrombosed popliteal artery. The patient, a milk roundsman aged 60, suffered from intermittent claudication at 100 yards.

FIG. 2.—The patient shown in Fig. 1 after an artery graft. He was back at work. (*See* Figs. 7 and 8.)

The technique of artery grafting was worked out in 1908 by Carrel and the methods in use to-day differ but little from his. The vessel is exposed and the thrombosed segment removed. It is here worth pointing out that extremely few collateral vessels are divided; in our patients in whom the graft has failed gangrene has not resulted—an important observation. A graft is inserted using a continuous everting mattress stitch. If the host vessels are normal we do not give heparin but in arteriosclerotic patients we consider that heparin is essential in the post-operative period. This may be given either in the form of systemic heparin or regional heparin. In our experience with either method and even with the most rigid control there is a definite risk of post-operative hæmatoma formation in the wound. We now control our heparin just as carefully but, in addition, leave the wound open for the first three or four post-operative days. Enough heparin is given to maintain the clotting time between fifteen and twenty minutes. This is stopped on the third day and on the fourth the operation of delayed

FIG. 3.—Thrombosed superficial femoral and proximal popliteal artery.

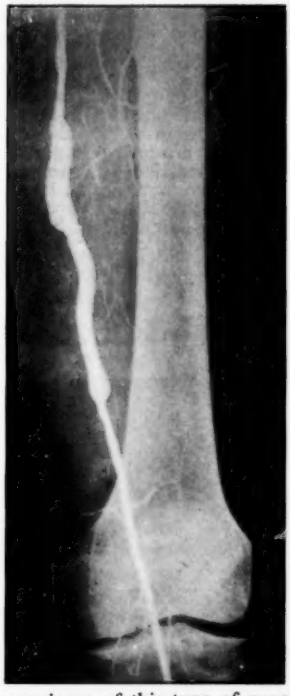

FIG. 4.—The patient shown in Fig. 3 six weeks after a saphenous vein graft. He is back at work.

primary suture is performed. Anybody who had experience of this type of procedure in the late war will agree, I think, that it is sound.

Post-operatively we have studied the blood flow in some of these patients. Figs. 5 and 6 are plethysmograph studies in such patients. It will be noted in Fig. 5 that the foot blood-flow, which is primarily through the skin, shows a considerable hyperæmia after the insertion of the graft. In Fig. 6 the calf

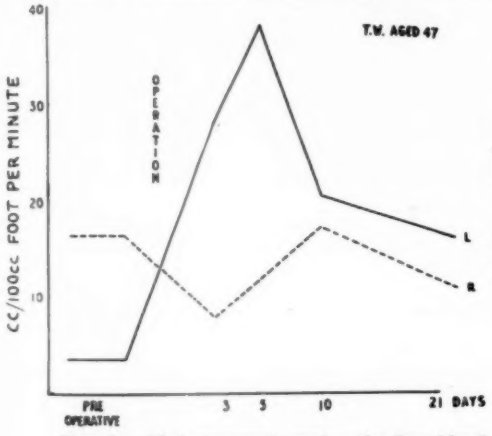

FIG. 5.—Plethysmograph study; the foot blood flow (skin) before and after a successful artery graft. Note the hyperæmia.

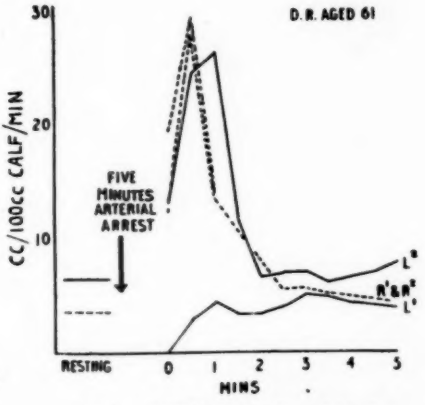

FIG. 6.—Calf blood flow (muscle) before and after an artery graft in left femoral artery. Note the response to five minutes' arterial arrest.

blood-flow, which is primarily a muscle blood flow, is shown. Here the important thing is to simulate the conditions which produce intermittent claudication. This is difficult to do as a direct measurement

but the response to five minutes' arterial arrest is in many ways comparable. Fig. 6 shows the minimal response before operation and the reasonably satisfactory response after it.

Before concluding I would like to describe one case and then to sound a note of warning.

The case was operated on just over a year ago and a graft inserted. Figs. 1 and 2 show his limb at that time. He returned to work and worked satisfactorily for just over six months. He then came up complaining that his symptoms had recurred and that in addition his great toe was going cold and black. An arteriogram showed a block in the femoral vessel just proximal to the area of the graft (Fig. 7) and he was developing early gangrene of the toe. At this stage we had really two alternatives: (1) to amputate his leg, or (2) to explore it and see if we could do anything further with local surgery. He was operated on and the host vessel was found to be blocked just proximal to the site of the graft. The area of thrombosis was resected and a new graft inserted, being anastomosed proximally to his host vessel and distally to the graft. Fig. 8 shows the post-operative arteriogram. His gangrene has now disappeared.

FIG. 7.—Arteriogram from the patient shown in Figs. 1 and 2. Six months later he had a new thrombus just proximal to the graft. His great toe was becoming gangrenous.

FIG. 8. — A second graft has been inserted joined at the distal end to the first. The toe has recovered and he has left hospital.

The note of warning: I want this to take two forms, first to stress again that we are dealing here with a general disease—arteriosclerosis. These patients are liable to thrombose their arteries, particularly the coronaries, cerebrals and vessels of the same leg or the vessels of the opposite leg. Their prognosis as regards life is poor and any local operation can only have a local effect. I think a graft is justifiable in every case where the alternative is an above-knee amputation, in other words some suitable patients with early gangrene. In the case of intermittent claudication I am doubtful in the majority of cases but feel that there are a minority which will be benefited. The second note of warning is the question of the fate of the graft. Artery grafts do not live; they die and are replaced by the tissues of the host, merely acting as a scaffolding while this process of creeping substitution occurs. There appears to be little, if any, risk of aneurysm except after a technically imperfect operation and in man, as yet, there appears to be no added risk of thrombosis, but we have not been using them for long and we may find that the late results are unsatisfactory.

Finally, I would like to say that coronary occlusion is a similar process to that occurring in the peripheral arteries. In animals one can anastomose an artery 3 mm. across with a reasonable prospect of success. There is no reason why in selected cases a coronary artery should not be grafted providing the

cardiac function can be maintained during the operation. I think this advance is only just round the corner. The real problem will be the selection of patients, not the technical performance of the operation.

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Mr. Frank Forty: I propose to confine my remarks on reconstructive arterial surgery to its use in the treatment of chronic peripheral arterial obliteration.

Let me first recall, however, that sympathetic denervation is our most generally effective remedy for the relief of ischæmia in endarteritis obliterans. Sympathectomy has given us a new orientation towards peripheral arterial disease with the acceptance of cases as surgical problems before the stage of gangrene. We are no longer satisfied to save the patient's life by timely amputation. We now aim not only to avoid amputation but also to restore useful function, and abolish pain in the limbs that we save.

Nevertheless, we cannot remain satisfied with the results of sympathetic surgery alone, for it is evident that the capacity of the collateral circulation, even when fully released from sympathetic control, is often insufficient to supply blood adequately for normal function. This is particularly true when an obliteration involves the level of the knee-joint, an area of skin and bone, where only scanty cutaneous collateral vessels exist to carry blood from the thigh to the leg.

Before trophic disturbances have supervened and when intermittent claudication is the only symptom, sympathectomy yields some 50% of successes with only 10% of amputations. But in cases with gangrene present the successes from sympathectomy fall to a mere 25% with over 70% of eventual major amputations.

We therefore have the duty to examine the possibilities of restoring the blood flow through the main arteries—possibilities suggested in 1947 when, with the help of anticoagulants, Dos Santos first performed disobliteration by thrombo-endarteriectomy and by the impressive results of vessel grafting in many branches of vascular surgery.

A priori, however, we are faced by certain obvious limitations when we seek to apply these methods in cases of thrombo-angiitis and atheromatous endarteritis.

(1) The arteries concerned are of poor quality and small size, their calibre often further reduced by intimal thickening above and below the actual site of obstruction—factors which increase the technical difficulties of suture and favour subsequent thrombosis.

(2) The obliterations are often extensive and multiple.

(3) The disease is a general one and progressive in the majority of cases, predisposing to fatal coronary or cerebral vascular accidents.

If reconstructive arterial surgery is to succeed in the face of these and other obstacles, dexterous technique is essential and the utmost care must be taken to avoid sudden falls in blood pressure, hæmorrhage, the formation of hæmatomas, and infection—all of which spell failure from secondary thrombosis if not worse disasters.

Most essential, however, is a thorough pre-operative evaluation of the general condition of the patient, of the state of the arterial tree, of the efficiency of the circulation, locally and generally, and an accurate determination of the site and extent of the obliteration and of the development of the collateral vessels.

Simple clinical methods suffice for estimation of the functional state of the circulation of the limb, but arteriography is indispensable for obtaining the precise knowledge of the pathological condition of the arteries necessary whenever reconstructive surgery is contemplated.

The arteriogram should include the whole limb and serial pictures are less liable to be erroneously interpreted than is a single exposure. Percutaneous puncture of the artery should be practised whenever possible, for this facilitates repeated examinations.

What do we require the arteriogram to tell us?

(1) *The site of the obliteration.*—Theoretically, any obliteration situated between the origin of the renal arteries and the bifurcation of the popliteal artery is technically amenable to reconstructive surgery. Below the popliteal, the arteries are too small and too difficult of access.

The larger the artery the easier will be the operation and the wider the lumen and the more powerful the current of blood within it, the less will be the chances of post-operative thrombosis.

(2) *The extent of the obliteration.*—This is to some extent a guide in choosing between disobliteration and grafting. A short segment of a few centimetres can be more easily and rapidly disobliterated than it can be grafted and with equally good chances of remaining patent.

The reverse is probably true in the case of very extensive obliterations.

(3) *The origin of important collaterals from the obliterated segment.*—Where this occurs, the indications will be for disobliteration, thereby restoring the collaterals to the circulation—instead of permanently sacrificing them by the performance of a graft, on the continued patency of which all will then be staked.

(4) *The state of the arterial wall above and below the obliteration.*—A wide lumen with a smooth outline indicates a healthy vessel wall transmitting a swiftly flowing current. Such an artery will be favourable for efficient suturing and will be least prone to post-operative thrombosis. An irregular, beaded outline of the vessel wall shows the presence of severe atheroma, contra-indicating any form of restorative operation.

(5) *The presence or absence of mulitiple segmental obliterations.*—Restoration of the patency of one segment of an artery will obviously be doomed to clinical failure if other important obliterations persist below it. From another point of view multiple obliterations also contra-indicate restorative operations for they imply a progressive activity of the disease—a thrombosis-proneness of the individual—which augurs badly for any lasting benefit even if a disobliteration or graft be initially successful.

(6) Lastly, but of cardinal importance, the arteriogram must show that *the blood-stream returns to and utilizes the main arteries below the obliteration.* No reconstructive surgery is possible unless this condition is fulfilled. When the blood is brought to the periphery solely by long collaterals arising above a high obliteration the results even of sympathectomy are poor and the prognosis for conservation of the limb is gloomy indeed. (Slides were shown illustrating the above.)

It is evident that the arteriographic findings will exclude many patients from the possibility of reconstructive surgery, in addition to those who are ineligible on account of the advanced stage of their ischæmia or of their precarious hold on life through age or other disabilities.

From this point of view, I have analysed a series of cases of chronic peripheral arterial obstruction seen at Edgware General Hospital.

Out of 86 cases, 25 were immediately excluded from the possibility of any conservative surgery on account of established gangrene (Stage 4), advanced age or feeble general condition. The remaining 61 cases were investigated by arteriography. Of these, 46 presented intermittent claudication as the only or principal symptom (Stage 2) and 15 had early trophic lesions including localized patches of gangrene, as of one or more toes (Stage 3). Table I shows the incidence of obliteration at different sites in cases of claudication and gangrene respectively.

TABLE I.—SITE OF ARTERIAL OBLITERATION

	Claudication	Gangrene	Total
Iliac	3	0	3
Femoral	22	7	29
Popliteal	4	1	5
Femoro-popliteal	2	2	4
Tibial	5	2	7
Multiple	2	1	3
Nil	8	2	10
	46	15	61

Arteriography demonstrated that in approximately one-third of the cases in Stages 2 and 3, the anatomical site of the obliteration, or the multiplicity of the lesions made it impossible to attempt any kind of reconstructive operation. There remained 41 cases, of which 30 were unsuitable for reconstructive surgery on account of one or other of the contra-indications which I have already referred to. Only 11 cases therefore fulfilled all the criteria for successful reconstructive surgery. On these patients I performed 10 disobliterations and one replacement with an autogenous saphenous-vein graft.

The technique of Disobliterative Endarteriectomy was fully described by Reboul and illustrated by a film at a meeting of the Clinical Section in March 1950 (Reboul and Laubry, 1950) (Fig. 1). I need therefore only recall the salient points:

(1) The incision must be long enough to expose the whole extent of the obliterated artery and a few extra centimetres at each end to allow comfortable clamping. Hæmostasis must be meticulous.

(2) The superficial aspect of the artery must be thoroughly cleaned—but the posterior aspect is not disturbed except where important collaterals have to be secured to control bleeding when their orifices are disobliterated.

(3) After making a small longitudinal incision into the arterial wall a plane of cleavage is sought and usually found without difficulty. This separates the inner coat which is necrosed and adherent to the contained thrombus—and which Bazy likened to a sequestrum—from the living outer coats of the artery. In different cases this plane of cleavage may occur either between the intima and the internal elastic lamina, through the media or between the media and the external elastic lamina. The incision in the arterial wall is now progressively extended over the whole length of the obliteration and the endarteriectomy completed by blunt dissection. When the limits of the thrombus have been passed the tube of endothelium is sectioned at each end and the occurrence of free bleeding from both directions is verified.

(4) Clamps previously placed in position are now tightened and the arterial incision is closed by a continuous suture of 5 × 0 black silk. On releasing the clamps, the disobliterated and distal segments

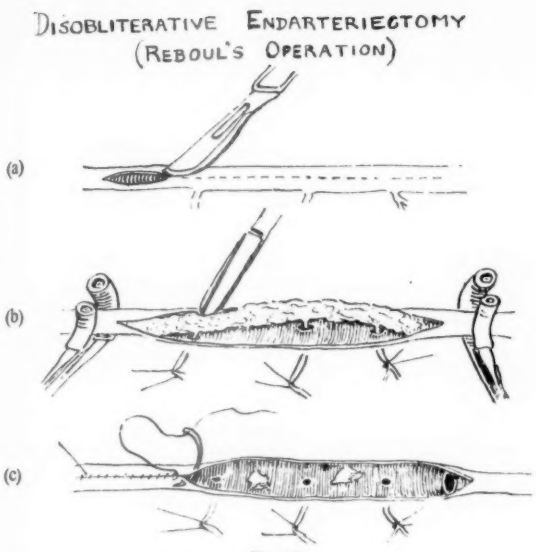

FIG. 1.

FIG. 1. — Steps of disobliterative endarteriectomy.

(a) Incision into arterial wall and definition of proper plane of cleavage.

(b) Separation of necrosed "end-arterium" with enclosed thrombus. Note extension of thrombus into the collaterals.

(c) Disobliteration of main vessel and collaterals completed and beginning of arterial suture. Adherent islets of necrosed inner wall may have to be removed separately.

FIG. 2A.

FIG. 2B.

FIG. 2C.

FIG. 2.—Chronic obliteration of lower two-thirds of superficial femoral artery. (A) Pre-operative arteriogram. (B) Arteriogram after disobliterative endarteriectomy. (C) Endarteriectomy specimen.

are seen to distend and pulsate. Additional interrupted sutures may be required to stop leaks at one or two points.

(5) The wound is closed with a drain.

Fig. 2 shows representative pre- and post-operative arteriograms together with the operation specimen.

A special word must be said with regard to the use of heparin. It was its discovery which gave the idea to Dos Santos that disobliteration might be attempted with success. Many of the failures have, however, been due to excessive administration of heparin resulting in fatal post-operative hæmorrhage, cerebral or coronary thromboses from fall in blood pressure, or large local hæmatomata with subsequent infection which have led to re-thrombosis of the artery.

Unfortunately variations in sensitivity to heparin between different persons and in the same person from time to time preclude any hard and fast rules governing dosage.

After some unpleasant experiences I have adopted the following plan:

(1) Heparin is applied locally to the artery throughout the stage of suture and a small quantity given intra-arterially as this is completed.

(2) Post-operatively heparin is given intravenously in divided doses not exceeding 50 mg., and only after the clotting time has been measured on a vaselined glass slide.

(3) The aim is to keep the clotting time lengthened to about fifteen minutes.

Here is the record of a case which illustrates the capricious response of the clotting time to three successive administrations of 50 mg. of heparin (Fig. 3).

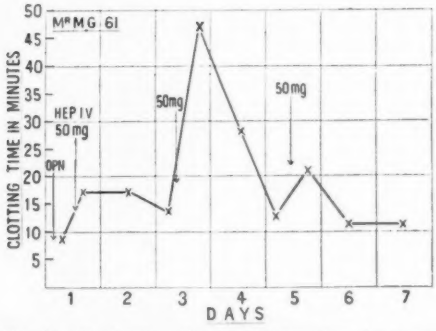

FIG. 3.—Graph showing fluctuations in the clotting time in response to successive administrations of heparin.

TABLE II.—RESULTS OF DISOBLITERATIVE ENDARTERIECTOMY

Author	No. of cases	Deaths	Amputations	Not improved or worse	Complete relief or improved: Remained permeable	Complete relief or improved: Re-obliterated	Complete relief or improved: Total
Leriche (Paris—1948)	7	1	0	0	4	2	6
Reboul and Laubry (Paris—1950) ..	93	11	5	10	44	23	67
Hoffmann *et al.* (Brussels—1950) ..	16	0	5	11	0	0	0
Wright (Hamburg—1951)	1	0	0	0	1	0	1
Fontaine (Strasbourg—1952)	22	4	5	5	2	6	8
Wylie (San Francisco—1952)	26	3	3	1	19	0	19
Forty (Edgware Gen. Hosp.—1952) ..	10	1	0	0	7	2	9
Total	175	20 (11%)	18 (10%)	27 (15%)	77 (44%)	33 (19%)	110 (63%)

Now as to the results of disobliteration.

Table II summarizes the results from various sources. It is a fairly representative list, including as it does some of the worst as well as the more favourable series. Also, it assembles a sufficiently large number of cases on which to form some opinion of the possibilities of the method.

In Table III I have analysed in rather more detail my own 10 cases of disobliteration, and one of saphenous vein-graft.

TABLE III.—AUTHORS' CASES OF ARTERIAL RECONSTRUCTION

Disobliterative Endarteriectomy

Case	Age	Stage	Site: artery	Extent	Result
1	67	Claudication. Gang. of toe	Sup. femoral	22 cm.	Relief of claudication. Gangrene healed
2	58	Claudication. Pain at rest	,,	15 cm.	Relief of claudication and of pain at rest
3	55	Claudication	,,	10 cm.	Relief of claudication
4	48	Gangrene of toes	,,	26 cm.	Died. Cerebral thrombosis
5	56	Claudication	,,	8 cm.	Relief of claudication
6	41	Claudication	,,	10 cm.	Partial relief; returned to full work
7	68	Claudication	Ext. iliac	5 cm.	Occ. slight claudication
8	59	Claudication	Sup. femoral	29 cm.	Claudication distance doubled
9	68	Claudication	Ext. iliac	3 cm.	Relief of claudication
10	61	Claudication	Sup. femoral	21 cm.	Occ. claudication after ¾ mile
			Saphenous Vein Graft		
11	53	Claudication	Sup. femoral	15 cm.	Relief of claudication

CONCLUSION

Disobliterative endarteriectomy is a feasible operation in certain cases of chronic endarteritis obliterans. In some of these cases, it is capable of giving results superior to those that can be obtained by vasodilatation of the collateral circulation.

It also has the advantage over grafting that it does not jeopardize useful collateral vessels, and may indeed restore them to useful function. Some of the results of disobliteration have been disappointing, owing to immediate or early re-thrombosis, but this may also occur after venous or preserved arterial grafts.

For better results in the future we can look to some refinements in technique and to more discriminating administration of heparin.

Even more promising, however, is a judicious appreciation of the indications and contra-indications according to the stage of the disease and the exact anatomical and pathological condition of the arteries, above and below as well as at the site of the obliteration.

The method employed must be carefully chosen to suit the particular case—vasodilatation, by sympathectomy or otherwise, disobliteration and grafting, either alone, or in combination, according to the needs of each individual patient.

(I am indebted to Miss M. H. Shaw for the photographs.)

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Mr. Henry Kidd emphasized the value of repairing damaged segments of major arteries by the use of vein grafts. He mentioned a case in which a segment of femoral artery had been removed in the course of an operation for varicose veins. He also stated that it was possible in dealing with long obliterated segments of artery to do a disobliterative endarteriectomy through a series of small incisions.

Mr. H. H. G. Eastcott described the artery bank in use at St. Mary's Hospital, with lantern slides to show its construction. A standard deep-freeze is fitted with a cork insulated Perspex box which holds about 25 lb. of solid carbon dioxide. Central spaces for the grafts are thus at −79° C. Grafts are collected sterile and are placed in dry sterile tubes and then frozen at −79° C. by immersing them in a freezing mixture of alcohol and solid carbon dioxide. This mixture is kept in the bank ready for freezing or for transporting grafts to the operating theatre or to other hospitals. Vascular homografts, whether frozen or fresh, do not survive in themselves but provide a satisfactory framework along

which the host tissues can grow. Rapid freezing can be innocuous. This was shown by photomicrographs of pieces of previously frozen arteries growing in tissue culture, and others surviving with normal histology and function when reimplanted into the original donor animal. He also mentioned the recent experiments proving that bulls' spermatozoa remain fully viable and fertile after freezing to −79° C. in 15% glycerol-saline medium and storage for nine days (Polge and Rowson, 1952). Human red cells had also been successfully transfused after similar treatment (Mollison and Sloviter, 1951). In artery grafting the relation of individual cell survival to the function of the tissue as a whole was unknown. But frozen arterial grafts, whether living or dead, gave results equally as good as unfrozen ones; and had this important advantage, that they could be banked in large numbers and in wide selection for as long as might be necessary before use in the patient.

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Mr. J. H. Peacock of Bristol pointed out that arterial grafts had been found experimentally by Deterling of New York to dilate after they had been in the abdomen for some years.

In reply **Mr. Brock** accepted Professor Rob's statements concerning the value of vein grafts for the restoration of arterial continuity in the limbs but said that this did not alter his own contention that the establishment of artery banks was an urgent necessity. He agreed with Mr. Forty that disobliterative endarteriectomy may well require to be done beyond the feasible limits of resection of a segment of artery.

Professor C. G. Rob, in reply to Mr. Peacock, said that calcification and dilatation in artery grafts had been observed in irradiated grafts or in chemically preserved grafts. It had not been seen to date in frozen artery grafts in either man or experimental animals and these had been in use much longer than the irradiated grafts which according to Deterling had calcified and dilated.

Mr. Forty pointed out that the method of doing disobliterative endarteriectomy through multiple incisions was the original method of Dos Santos but was modified by Reboul to the single long incision so as to ensure that the disobliteration was all done in the same plane of cleavage and that the residual arterial wall was left with a perfectly smooth lining.

Section of Laryngology

President—J. P. STEWART, M.D., F.R.C.S.Ed.

[*November* 7, 1952]

Cortisone and ACTH in the Treatment of Allergic Rhinitis [*Abridged*]

PRESIDENT'S ADDRESS

By J. P. STEWART, M.D., F.R.C.S.Ed.,
and M. Z. KAWA, M.B., Ch.B.

THESE remarks are based on the personal observations and investigations carried out by Dr. Kawa and myself on the therapeutic effects of cortisone and ACTH in 33 cases of nasal allergy, which do not, however, include hay fever. I propose to give a general outline of the origin and physiological actions of these substances, as well as the effects of treatment by them.

THEORIES OF ACTION OF CORTISONE AND ACTH IN ALLERGY

Allergic rhinitis may be interpreted as being the result of the reaction of the nasal mucosa to antigens causing a local release of histamine.

Dill and Bolstad (1951) emphasized that the exact mode of action of cortisone on the tissues was not definitely known but they believed that it caused a blocking or neutralizing effect on the antigen-antibody union and thus a local desensitization of the tissue might result. Harvey (1950) presumed that in addition to those foreign proteins which excite hypersensibility, simple chemical substances and organic products of micro-organisms also played a part. These latter were not true antigens but they could combine with body proteins to form an antigenic complex and so prepare the tissues for an allergic inflammatory reaction. A somewhat attractive supposition which he made was that a direct injury to the cell might result from the union of antigen with antibody with the consequent liberation of histamine. He concluded that a given antigen might produce very widely divergent reactions in different individuals.

Hollander (1951) stated that ACTH did not cure disease but blocked harmful reaction in many cases. He cited as an example cases of rheumatoid arthritis in which colds rarely occur because they are in a non-specific hyperimmune state, but when treated by ACTH or cortisone, colds varying in severity and frequency did occur so that one effect of these substances was to change the mechanism of immunity. He continued that it was known physiologically that ACTH, by stimulation of the adrenal cortex, caused a lysis of lymphocytes, a release of antibodies and then a decrease in the amount of immune bodies. We have noticed in a great many, indeed we might say every one of our patients, that immediately after, or sometimes during, maintenance treatment a severe head cold developed and this would agree with Hollander's observations on the changes in immunity.

Thorn *et al.* (1950) in their experimental work on the adrenal gland of the rat found that the adrenal cortex bore a direct relationship to the metabolism of histamine and its specific enzyme, histaminase, as the tissue and blood histamine was markedly increased and the mechanism for the destruction of histamine was impaired following removal of the adrenal gland. These changes could be fully compensated for by the administration of cortin (presumably Compound E or F,) but no difference could be detected when desoxycorticosterone was administered.

Russell (1950) thought that as quite mild degrees of stress, such as allergic manifestations, could cause a stimulation of the anterior lobe of the pituitary gland, then additional adrenal cortex hormone was secreted, to enable the patient with allergic symptoms to deal with the allergen.

Randolph and Rollins (1950) have proved that ACTH protected the patient suffering from allergy from the experimental exposure to allergens for which the patient had a specific sensitivity. This suggested that the basic mechanism of allergic disease was closely related to the function of the pituitary-adrenal system.

Green and Whiteley (1952) theorized from the standpoint of the inhibitory action of ACTH and cortisone on epidermal mitoses in the hypersensitive states. The antibody formation was retarded, not by any chemical antagonism, but because the short-lived, antibody-forming mesenchymal cells were not replaced.

Such then are some of the theories of the action of cortisone and ACTH on the tissues in the hypersensitive state.

Clinical Material and Methods of Investigation

The clinical material for this investigation consisted of 33 patients of whom 24 were females and 9 males and their ages ranged from 11 to 61 years. 12 cases gave a family history of allergy. 13 cases were married. Our diagnosis was based on three main symptoms which generally were present in the following sequence: attacks of sneezing which took place first thing in the morning, followed by nasal obstruction, and then a clear, profuse discharge which occurred after the relief of the obstruction. The diagnosis also depended upon the appearance of the interior of the nose as seen on anterior and posterior rhinoscopy; this showed the unmistakable picture of allergy of the soft tissues. Each case underwent an X-ray examination of the chest to make sure that there was no active or recent tuberculous infection in the lungs, a condition which would most certainly have barred any treatment by cortisone and ACTH. An X-ray examination of the paranasal sinuses was also carried out to eliminate any gross underlying infective process as such cases would have been unsuitable for this Address. We found that 12 of the cases showed soft tissue swelling in one or both of the antra while the remaining 21 cases were normal. In those cases which showed changes, a further X-ray was taken on the conclusion of the initial treatment and all except one showed an improvement in the air-containing space and a shrinkage of the swollen soft tissues.

The X-ray examination of the chest showed that 25 cases were quite clear and 8 showed a mild degree of emphysema or slight bronchial change. *On admission* to hospital a blood count was taken, hæmoglobin estimated, and blood pressure and weight recorded. The urine was tested for albumin and sugar as either would have been a possible contra-indication for treatment. A small piece of tissue from the nasal mucosa was taken for biopsy. *After treatment was commenced* serial eosinophil and leucocyte counts were made each day, exactly three hours after a selected injection of cortisone or ACTH. In the early stages the nasal secretions were examined for shed eosinophil cells but they were too disintegrated to count. The urine was examined daily and in only 2 cases a very temporary trace of sugar was found on the morning of the second day of treatment. The nose was examined each day and in some cases at intervals of a few hours to note if any retrogression had taken place in the soft tissues. The weight was checked daily and the temperature and pulse-rate were recorded every four hours but in none of the cases did the four-hourly chart show any variation and the daily blood pressure was unaltered. (Our highest recorded blood pressure was 240/140 in a lady aged 61.) The mental make-up of the patient was studied for euphoria which was found to be invariably present. *Prior to discharge* from hospital a second biopsy from the same region of the nose as the first was taken.

The day following their discharge from hospital they returned to commence their maintenance treatment as out-patients. In those cases which lived some distance away, supplies of cortisone or ACTH were given to the family doctor. They reported regularly and the dosage was adjusted according to their responses.

Physiological Action of Cortisone and ACTH on Tissues

There is no appreciable difference in the physiological action of cortisone and ACTH. Mahoney (1952) drew attention to the antagonistic action which occurred between the adrenal cortical steroids and the insulin and thyroid hormones, and also those known to exist between the actual adrenal cortical steroids themselves.

Russell (1950) summarized the action of the physiological effects of cortisone and ACTH on the salt and water balance and related processes, on organic metabolism (carbohydrate, protein and fat), on lymphoid and mesenchymal tissues, and on resistance to changes in environment and stress of various types.

Sodium and water balance.—Œdema occurring in adrenal insufficiency may be due either to salt retention and delayed water excretion or to stimulation of the posterior lobe of the pituitary gland causing production of the anti-diuretic hormone. Large doses of cortisone may well produce this,

especially in the presence of damaged kidney tissue. Prunty (1952) found considerable variation in the effect of ACTH on sodium and chloride excretion. Some cases showed a transient retention of those ions while others had a prolonged retention with the exhibition of œdema. He thought it possible that there was an adrenal hormone predominantly concerned with electrolyte metabolism. He also suggested that adrenal cortical hormones promoted a shift of fluid from the cells to extracellular fluid, and that this increase in the volume of extracellular fluid might affect renal excretion of salt and water. In the early stages of administration of the hormone retention of salt is common, while later on there may be an increased excretion. In a few cases, mild increases in the urinary excretion of calcium and phosphorus have also been noted.

Cortisone and ACTH can upset *the protein metabolism* and cause an increase in the creatinine and uric acid in the urine, and also bring about a decreased balance of potassium. Brown (1951) drew attention to the depression of the thyroid function and basal metabolic rate and also stressed the stimulation of the pancreas with the production of insulin and a period of hypoglycæmia but with the ultimate exhaustion of the pancreas and frank diabetes mellitus.

Patients under treatment with cortisone or ACTH and suffering from diabetes mellitus require an increased dose of insulin to offset the specific effects of these substances on carbohydrate metabolism.

Further effects of ACTH and cortisone were observed on the functions of the anterior lobe of the pituitary gland, with resulting depression of the gonadal function and inhibition or delay in the menses. These changes were found more frequently in the young female. The menses were unaffected in our cases possibly because of the low dosage employed. Ragan *et al.* (1950) have written on the mechanism of cortisone and ACTH which led to the suppression and decrease in the connective tissue in response to trauma, and we will discuss our findings on this under the section on Histopathology. They mentioned the catabolic or anti-anabolic effect of hyperadrenalism on protein metabolism which they thought might reflect the decreased reactivity of the mesenchymal tissues. They also wrote that it was apparent that the response of mesenchymal or collagen disease to the administration of cortisone and ACTH was not readily related to the known functions of the adrenal cortex.

Because of this *peculiar response of the connective tissue to* cortisone and ACTH therapy, cases suffering from active or recent pulmonary tuberculous infection were considered unsuitable for treatment with these drugs. Peptic ulcer has been considered by some to be a contra-indication to treatment as an increased peptic activity and gastric acidity followed the exhibition of ACTH, but this did not occur during treatment by cortisone. This increased activity of pepsin and hydrochloric acid might lead to a breakdown of the ulcer and in a few cases where there was no previous clinical evidence of ulceration, alarming hæmorrhage and even perforation might occur.

The "side-effects", so-called, which followed the administration of cortisone and ACTH were intimately bound up with the physiological action of these substances. The main "side effects", apart from those we have already considered, were an increase in body weight presumably due to the unrestricted diet in the patient who experienced a sense of well-being with increased appetite. In a few cases increase in weight may have been dependent on the salt and water retention factor. Franklin and Lowell (1950) stated that cortisone appeared to cause increased appetite more readily than ACTH. In at least 3 cases in our series there was a marked increase in weight. In our cases there was no occurrence of "moon face", which is considered to be one of the earliest signs of overdosage. Keratosis pilaris has also been noted. Acne and hirsutism, again not seen in our series, were possibly due to weak androgenic effects of cortisone, or the cortisone might be metabolized to yield androgenic compounds (Sprague *et al.*, 1950). The only "side effects" which we encountered apart from the invariable head cold which the patients contracted towards the end of their treatment and the increase in weight, occurred in 2 patients, both receiving treatment with ACTH, one of whom developed an intense but short-lived urticaria well on in her treatment. The other, a young girl, during her initial course of treatment showed raised patches on the skin behind the knees and on the back of the hand, which a dermatologist said was without doubt due to treatment with ACTH.

Euphoria was invariably present in our series of patients. In the consideration of treatment by cortisone or ACTH the mental "make-up" of the patient must be carefully considered as an incipient mental breakdown could easily be aggravated.

Just as in the early days of penicillin, ACTH may contain some impurities which give rise to an otherwise unexplained temperature. Abdominal symptoms such as cramp, flatus and nausea may be due to the accidental inclusion of some of the substances from the posterior lobe of the pituitary and pigmentation of the skin may arise from the inclusion of part of the pars intermedia. Indeed ACTH might even act as a foreign protein and produce allergic manifestations (Hench *et al.*, 1950).

The Blood Picture

It is generally recognized that the eosinophil count is taken as an index of the activity of the adrenal cortex and an eosinopenia as an expression of the plasma concentration of the adrenocortical steroids. Thorn and his co-workers (1950) used an injection of 25 units of ACTH prior to treatment

in order to assess the response in the fall of eosinophils and regarded this as a useful indication as to whether treatment would be successful or not. Randolph and Rollins (1950) have made some interesting observations on eosinophils in cases under treatment with ACTH. They found that after an efficient dose of ACTH the greatest degree of eosinopenia occurred between three and five hours later, and, further, that eosinophils may disappear from the blood irrespective of the level of the pre-existing count, while a low initial eosinophil count suggested that in such patients an overdosage result was likely. The continued absence of eosinophils during the first twenty-four hours with ACTH either signified adequate dosage or it might be one of the first danger signals of overdosage. When the eosinophils failed to disappear from the peripheral blood stream during the first twenty-four hours it was considered as a clinically inadequate therapeutic response and might be regarded as an underdose of ACTH which possibly followed an inadequate absorption of ACTH from the site of the injection, inactivation of the hormone by proteolytic enzymes, or some impediment in the pathway of the pituitary-adrenal association. Besides eosinopenia the blood showed transient leucopenia with a subsequent leucocytosis, but we have not observed a transient leucopenia. Generally speaking, in those cases which showed a normal white cell count before treatment, we found that the leucocyte count became increased during treatment. We found a progressive decrease in the number of circulating lymphocytes to as low as 8% with a corresponding increase of neutrophil polymorphs to as much as 88%. 10 cases prior to treatment showed a leucocytosis ranging from over 10,000 to 16,000 cells. During treatment, 3 of those cases showed a further increase in the number of leucocytes, while in 3 others the white blood count remained stationary; in the remaining 4 cases the white cells returned to a normal number.

We noted a decrease proceeding to a complete absence of eosinophils in 12 cases, and a very marked decrease in their number in 14 cases. There was only a slight decrease in 7 cases but in all cases a reduction varying from a slight to a total loss was present. Possibly in a certain number of cases the failure of the eosinophils to disappear completely from the peripheral blood stream was due to the relatively small doses of cortisone and ACTH which we employed. We found the eosinopenia in roughly the same proportion irrespective of whether cortisone or ACTH was used.

Franklin and Lowell (1950) found a low eosinophil count to be roughly parallel to the clinical improvement and that the eosinophil count might be used to regulate the dose of either hormone. They also remarked that when the treatment was finished the eosinophil count might return to normal without a return of the symptoms. Dougherty and Schneebeli (1950) suggested that when the eosinophils disappeared from the peripheral blood stream under the influence of the adrenal steroids they were to be found accumulated in the subcutaneous mesenchymal or similar tissues.

Mode of Administration

CORTISONE

The cortisone used in our investigation was that manufactured by Merck and Co. of New York. It is in the form of a saline suspension of cortisone acetate.

Cortisone is most commonly given by the intramuscular route by a single daily injection, or, in our experience, it is better divided and administered at six-hourly intervals during the active stage of treatment. It may also be administered by the mouth either as tablets or in suspension. The tablet is usually 25 mg. or, if in suspension, a similar dose in 4 c.c. bulk. The oral route is considered quite satisfactory but larger doses have been found necessary to achieve the same results as by intramuscular injection. This may be because cortisone when given by the mouth travels to the systemic circulation by way of the liver and in the unresponsive patient a larger proportion of the hormone may have been inactivated (Kellgren, 1952). Boland and Headley (1951) further suggested that cortisone was more rapidly absorbed by the intestinal tract than when given intramuscularly and therefore the effects were dissipated more quickly. The tablets are best given four times daily and are as a rule well tolerated. Kuzell and Schaffarzick (1950) were of the opinion that 1·25 to 3 mg. cortisone given orally was required to equal the effect of 1 mg. by the intramuscular route. Local application of cortisone has also been used; 10 mg. of this substance is incorporated in 1 c.c. of normal saline and applied in a nose spray several times each day. This solution has keeping properties of about one week. Bordley (1950) reported good results with this method though Harvey (1950) and also Dill and Bolstad (1951) observed that the use of a cortisone nose spray produced only temporary relief of the nasal symptoms. They did not find any atrophy of the nasal mucous membrane following its use. Sheehan and Summers (1952) reported a desperate case where they gave the standard suspension of cortisone acetate in saline by the intravenous route. The patient unfortunately died. At the post-mortem no lesions were demonstrated to indicate that this administration had had any deleterious effects.

ACTH

We have employed in our cases the ordinary ACTH as manufactured by Armour. There is, however, a long-acting brand of ACTH, one full dose of which is sufficient to cover the twenty-four-

hour period. It is given subcutaneously. High potency ACTH gel (Fraction D of Astwood) is also available.

ACTH cannot be given by mouth as the hormone is destroyed in the gastro-intestinal tract. It is usually given intramuscularly in divided doses at six-hourly intervals and we have followed this practice. Another difference from cortisone is that it may be given intravenously, and very satisfactory results have been obtained by this method. Gordon (1950) gave the required dose in a 5% solution of glucose by the constant drip method. He maintained, as did also Renold *et al.* (1951), that this ensured a prolonged stimulation pressure on the adrenals and therefore a much greater output of the adrenal steroids was obtained than by the more brief stimulation occasioned by an intramuscular injection. Intravenous administration has, of course, very obvious disadvantages and besides there is always the possibility, though remote, of the production of an anaphylactoid or hypersensitive reaction. ACTH has also been applied locally with good results by Bordley (1950) and Boland and Headley (1951). We have also used ACTH as a nose spray, following the initial treatment by the intramuscular route in 8 cases. Only in 3 was this method of treatment by itself successful; the other 5 cases required maintenance doses by injection as well.

Cortisone given in suspension by the intramuscular route is absorbed slowly in contrast to the more rapid absorption of ACTH by the same route. Kellgren and his associates (1952) stated that the effects of ACTH reached a maximum some six hours after injection while cortisone given by the same route (intramuscular) was relatively slowly absorbed and took twenty-four hours to reach its maximum. To achieve the same rate of absorption as ACTH, cortisone must be given by mouth since the effects of a single dose of cortisone by this route closely resemble that of a single intramuscular injection of ACTH. They assessed 25 units of ACTH by intramuscular injection as being comparable to 50 mg. of cortisone by mouth. The overall effects of these two substances may be "boosted" by doses of thyroxine and ascorbic acid.

Administration of cortisone and ACTH in excessive amounts or for too long periods may cause temporary partial atrophy of the adrenal cortex producing, amongst other symptoms, muscular weakness and asthenia.

We have used cortisone by itself in 6 cases, cortisone combined with ACTH in 4, and ACTH alone in 23 cases. Where the initial treatment was by cortisone, and maintenance treatment carried on by ACTH there was a marked resistance at first to this latter drug on the part of the patient. Our routine of administration for both cortisone and ACTH has been by intramuscular injection in doses of 10 to 25 mg. of the former and 10 to 25 units of the latter according to the clinical response of the patient, every six hours, for a primary period of five days, during which time the patient was in hospital. Thereafter in the ACTH patients a maintenance dose of 10 units was given on three consecutive days for the first week, 10 units every alternate day for 3 doses during the second week, 10 units for two doses spaced equally out in the third week, and finally 10 units were given once during the last or fourth week. It is important to observe this sequence of the dosage times. The routine adopted for maintenance treatment by cortisone followed on similar lines except that the dose of cortisone given was 25 mg. We gave cortisone in 12·5 mg. doses and ACTH in 10 unit doses to our cases under the age of 17, of which there were 8, throughout the course of their treatment.

In the unresponsive patient this maintenance dose was prolonged from the above period to as long as three months—the maximum dose being 10 to 20 units of ACTH given thrice weekly. Dameshek (1952) states that 150–300 units of ACTH daily may safely be administered in the more severe illnesses.

Histopathology

A specimen from each patient of the soft tissue of an inferior turbinate was examined microscopically to confirm the clinical diagnosis and also to ascertain whether such tissue provided any basis for prognosis in treatment with ACTH and cortisone. Tissue was also taken from the same region from a clinically healthy nose. It was with some difficulty that we were able eventually to obtain normal tissue from an inferior turbinate as most of our biopsies showed chronic inflammatory changes. This is not so absurd if we remember that the nasal mucosa is subjected to many and repeated attacks of acute rhinitis (common cold) and there must eventually be some residual inflammatory changes in the tissues. On the conclusion of the initial five days' treatment a second biopsy was taken from the same area in order to find out the changes in the tissues during treatment. On our first clinical examination of the nose we noted that 18 cases showed the typical pale rather bluish coloration of the mucous membrane along with a soggy œdematous appearance of the soft tissues combined with clear discharge which we associate with simple allergy, while the other 15 cases showed a rather congested moderately œdematous mucous membrane which was in keeping with the appearance of a simple allergy combined with a mild infective process. Rather to our surprise, of the typical simple allergic group, only 11 of the 18 cases showed the microscopical features of a simple allergy such as loss of cilia and other changes in the epithelium, free infiltration of the connective tissue spaces with marked œdema caused by increased permeability of the capillaries, which are chiefly present in the area between the basement membrane and the dilated

glandular structures, dilatation of the blood vessels and the presence of many eosinophils chiefly congregated near to the basement membrane or actually making their way through the epithelial layer to be cast off in a state of degeneration into the nasal secretions.

The remaining 7 cases of this first group showed all the features of a chronic allergic rhinitis with hyperplasia of the epithelium, broadening of the basement membrane, round-cell, mainly lymphocytic, infiltration of the submucous layer, œdema of the stroma, dilatation of the blood spaces and eosinophils in varying concentrations. In the second group of 15 cases where the appearances on clinical examination were those of an allergic condition complicated by bacterial infection, histological examination disclosed that 7 gave the typical appearance of a simple allergic and 8 those of a chronic allergic rhinitis. Thus there was no parallel relationship between the macroscopical and microscopical findings of the nasal mucosa. Histological examination of the various sections reveals that there are some which display the typical appearances seen in an uncomplicated allergy whilst in others the infective processes overshadow the allergic formations; the remainder show features of both these conditions of allergy and infection. Further, we can find no constant relationship between the disappearance of the eosinophils from the peripheral blood stream and the findings at the second biopsy—as in several such cases the eosinophils were still present in the submucous tissues in the same proportion as when the treatment was initiated. On the other hand in some cases where the eosinophils were absent in the blood they also disappeared from the submucous tissue and indeed the appearance of these tissues changed from the typical simple allergic formations to one identical in appearance with a chronic allergic rhinitis. From a close scrutiny of the eosinophil factor in both blood and submucous tissue of the nose, and the clinical responses of the patient, we can state that the disappearance of the eosinophils from these two media indicates a favourable outcome to the treatment.

As healing of the connective tissue elements in traumatized tissue is said to be greatly delayed during the administration of cortisone and ACTH we examined the material at our disposal on this point both macroscopically and microscopically and with a normal control. We could certainly confirm this delay in healing from the clinical day-to-day picture, as the soft tissues of the traumatized inferior turbinate were slow to heal and showed little reaction. There was a tendency to a slight oozing of blood for some days following biopsy, but in only one case did this ooze continue for fourteen days and it was in no way alarming or harmful. In order to ascertain the amount of healing which had taken place during the initial treatment we took a further specimen of tissue from the inferior turbinate from precisely the same area as the first biopsy. We also took as a control a sample of similarly traumatized tissue from a "normal" and an "allergic" inferior turbinate, at the same interval of time, which had not been subjected to treatment by cortisone or ACTH. Furthermore there was the question of whether there was any appreciable difference in the rate of healing between the histologically simple allergic and the chronic allergic cases of rhinitis under treatment. From our examination of the sections of patients treated by cortisone or ACTH we found that there was a *very definite* delay in reaction and healing. Capillary formation, fibroblastic proliferation and deposition of collagen were weak and very much subnormal, and the red blood cells which were cemented together on the traumatized surface showed practically no signs of organization. The clinical and microscopical appearances of delay in healing were therefore similar. We also found no difference in the rate of healing in the simple allergic and the chronic allergic group.

Results of Treatment

The present investigation has been undertaken during the last six months so that we have only short-term results of treatment and we must wait for a further period for long-term results. The patients under review have all been examined within the last few weeks to obtain the most recent results of treatment.

Apart from 2 patients who gave up the unequal struggle after their discharge from hospital, the remaining 31 cases have very dutifully carried out their maintenance treatment. Possibly the fact that their symptoms were under control and that therefore life was so very much more worth while contributed to this factor. The response to the initial treatment was quite dramatic as the symptoms practically disappeared following the first twenty-four hours and remained absent during the time they were in hospital.

In a number of cases which showed a marked improvement during the initial stage of treatment the alleviation of their symptoms was not maintained even with adequate maintenance doses (the rebound phenomenon). However, after all treatment had been suspended and after a certain lapse of time their allergic symptoms tended to disappear gradually, so much so, that in a matter of weeks or months they could be regarded as much improved or even quite free of symptoms. Therefore no opinion should be expressed on apparently negative early responses and the patient can be assured that there is still a good prospect of permanent relief. 8 cases under the age of 17 reacted extremely well showing 7 completely free of symptoms and 1 much improved. Thus the prognosis in the younger age group is very favourable.

Summary

We have based our diagnosis of allergy on three main symptoms, sneezing, nasal obstruction and a clear nasal discharge, also on the appearances seen on anterior and posterior rhinoscopy. Our criteria of cure were the complete disappearance of those symptoms and a return of the nasal mucous membrane to normal.

The patients have been divided into three groups according to the treatment they received:

Group A: 6 cases treated by cortisone only. The result was 3 completely free of symptoms, 2 much improved and 1 improved.

Group B: 4 cases treated by a combination of cortisone and ACTH. 2 cases were completely relieved, 1 was much improved and 1 failed to continue treatment although he had greatly improved while in hospital.

Group C: 23 cases treated solely by ACTH. 14 were reported as being free of symptoms, 7 were much improved, 1 improved and 1 unimproved. This last patient was pregnant. She received her initial course or treatment and commenced, but did not finish, her course of maintenance treatment. She was vastly improved during her treatment but she herself says that her symptoms have worsened again. This would tend to support our view that the symptoms of nasal allergy are more pronounced during pregnancy.

When the results of these three groups are compared as a whole we have 19 free of symptoms, 10 much improved, 2 improved, 1 unimproved and 1 failed to continue treatment.

Comment

We have evolved a form of treatment for simple, and chronic allergic rhinitis with cortisone and ACTH where a large proportion of the cases so treated have been free of symptoms or vastly improved. We consider this treatment reasonably safe if carried out with intelligence and care, and if used in selected cases and not indiscriminately. From the low dosage employed no marked "side effects" are to be expected. It would be reasonable to examine the urine and have an X-ray examination of the chest performed before treatment is commenced. There is no particular need for hospitalization of the patient and treatment could be carried out in the patient's home or even as an out-patient. ACTH (in the long-acting vehicle) can be given by injection every twenty-four hours or cortisone may be prescribed as tablets so that there would be no undue strain on the services of the doctor.

We wish to record our thanks to Dr. R. F. Ogilvie, Pathologist to the Royal Infirmary, Edinburgh, for his reports; to Mrs. Maurice Anderson for her generous donation of cortisone and to Professor D. M. Dunlop for ample supplies of ACTH.

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Mr. C. A. Hutchinson said that he was, at present, carrying out a series of experiments with cortisone which would be published later. These experiments were not in connexion with the nose and throat but with the ear. Cortisone having an inhibitory effect on all tissue activity with the sole exception of epithelialization, it had occurred to him that it might be of some use in connexion with the healing of post-fenestration and radical mastoidectomy cavities. He had found that cortisone used in a saline suspension had an immediate irritative effect. Sir Stewart Duke-Elder had told him of another suspension medium.[1] With this the speaker had got rapid and smooth epithelialization in both types of cavity without troublesome granulations which had been not infrequent before and which had sometimes shown almost polypoid formation.

He therefore asked the President whether he had had any similar irritative effects when using cortisone in ordinary saline as a topical application.

Mr. H. V. Forster asked the President if his series of cases included some patients with the complication of ethmoidal mucous polypi. Had the polypi appeared to retreat under the administration of corticotrophin or cortisone? Some American observers reported by Henry L. Williams (1952, *Ann. Otol. Rhin. Laryng.*, **61**, 497) appear to have observed this partial recession of the growths.

The President, in reply, said that he had treated a case of allergic rhinitis where there was an infected fenestration cavity and under ACTH treatment the allergic rhinitis had cleared up and also the discharge from the cavity. They had had another case of a boy with a mastoid cavity full of granulation and fibrous tissue who had been in and out of hospital for years and it was decided to give him a series of injections to inhibit further growth of the tissues after clearing them out. He was sorry to say that in this case the treatment had no effect at all. In nasal polypi the treatment had been used locally and also by injection and it did reduce the trouble, but only temporarily. As soon as the treatment was stopped the polypi returned.

[1] **Suspension medium:** A dilution of 1 volume of the commercially available saline suspension of Cortone Acetate (Merck) with 4 volumes of the following buffer solution:

Sodium acid phosphate with one molecule water	4·6 grammes
Sodium phosphate anhydrous	4·7 grammes
Sodium chloride	4·8 grammes
Benzylalkonium chloride	1 : 5000 q.s.

(Quantity sufficient to make 1,000 c.c.)